Vegetation Shifts in the Sierra Nevada Over the Past 100 Years

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Weather trends in the Central and Northern Sierra Nevada

The Wieslander Vegetation Survey

Vegetation Change in the Sierra Nevada

Vegetation Plot Revisits

Some ideas for integrated monitoring

Terrestrial Plant Response to Climate Change

Mountains as Gradient Systems
Vertical vs Horizontal

Species Elevation Distributions

Leading Edge Dynamic
Easy to record
Dependent on growth

Trailing Edge Dynamic
is messy to detect
mortality/replacement
rapid or slow

Within Vegetation Band
a vegetation type
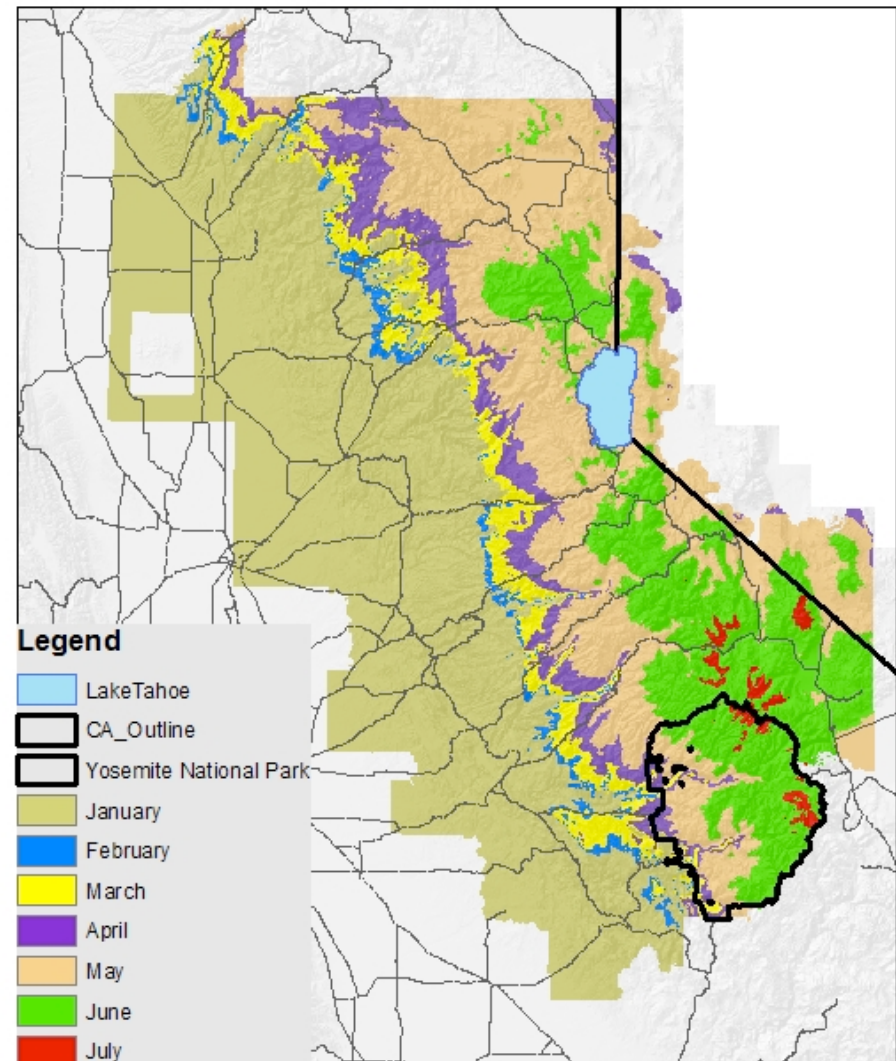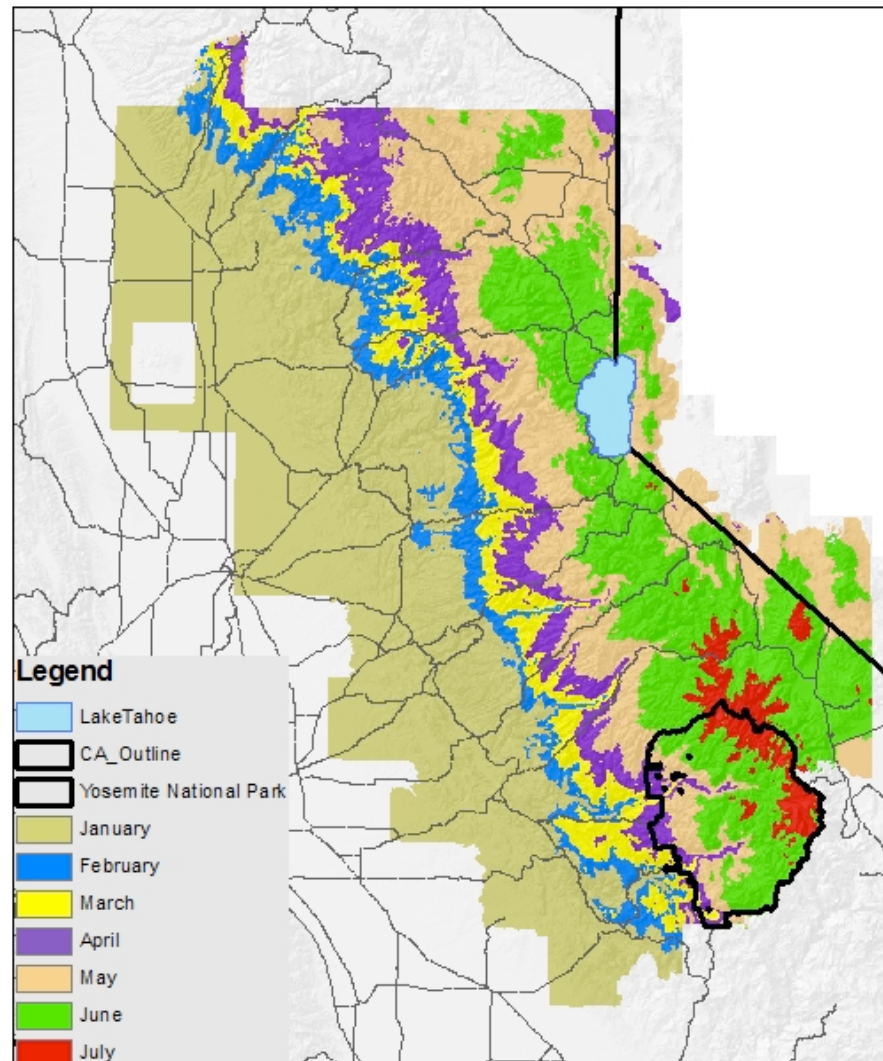can have increased or decreased

Life Cycle timing may change
Phenology
Population dynamics

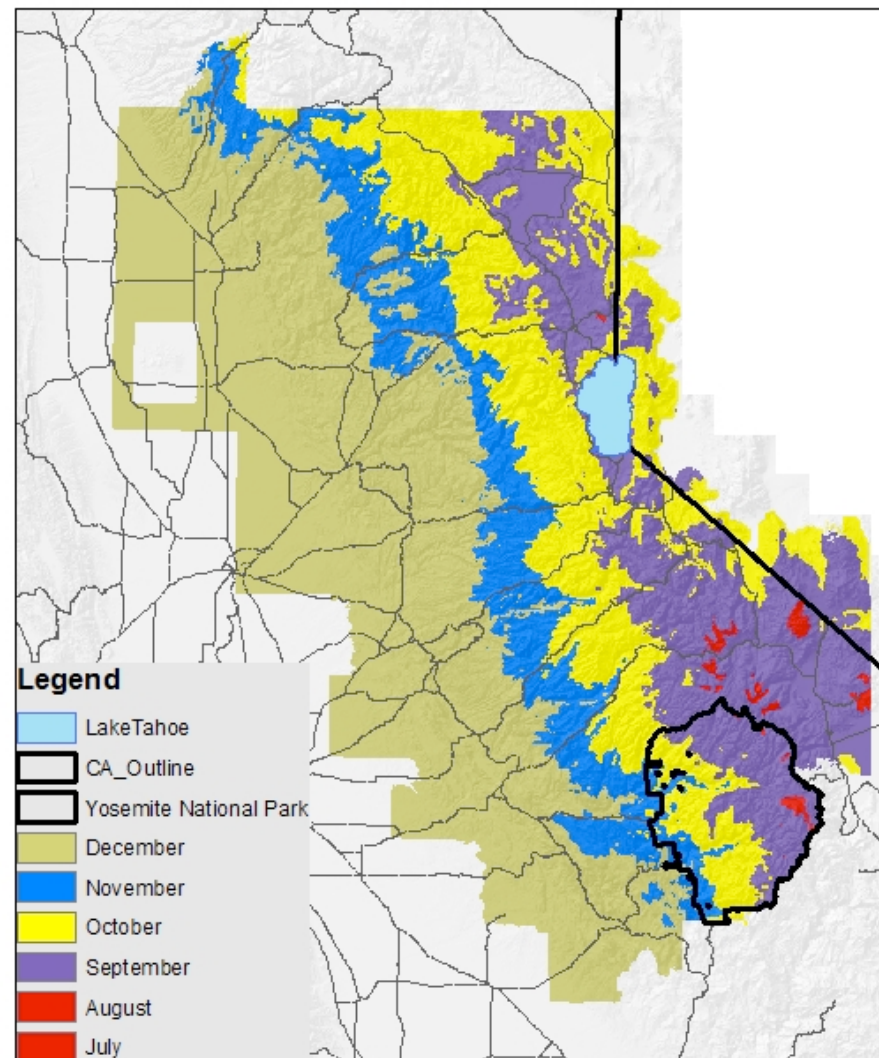# January to June Freezeline Dynamics: 1934 and 2004

1934

2004

Legend
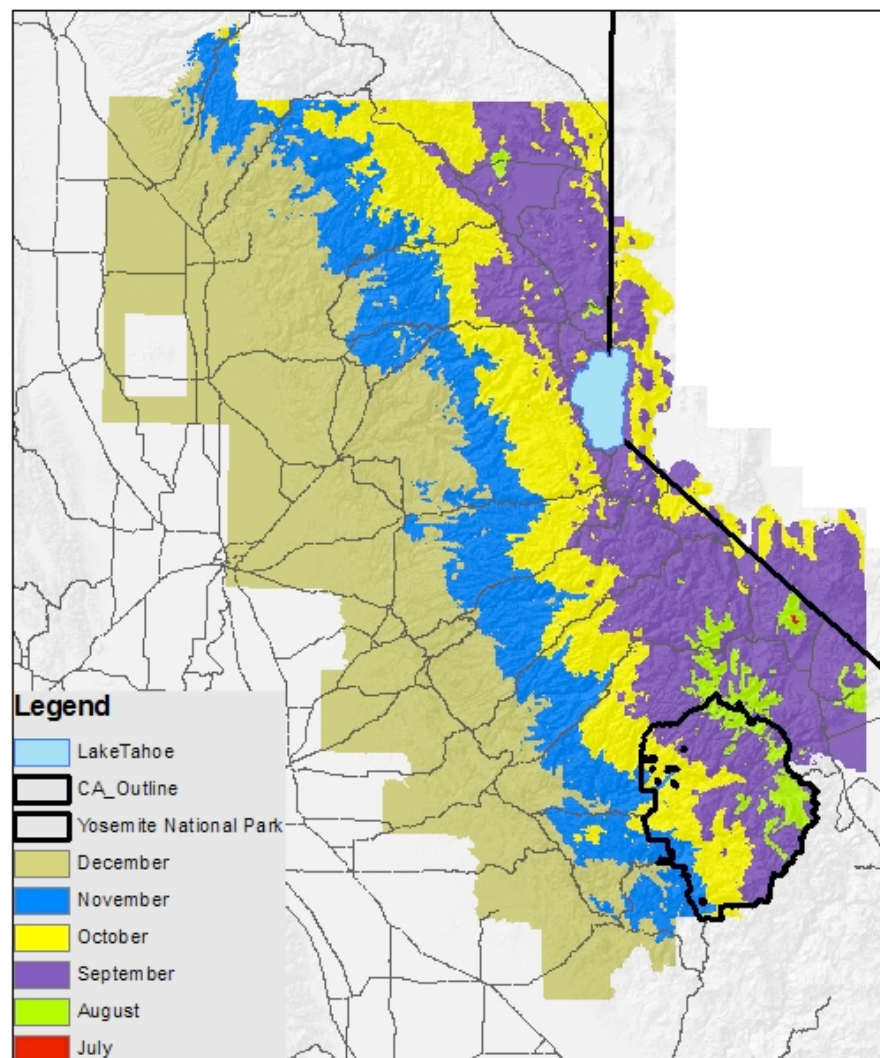
- **LakeTahoe**
- **CA_Outline**
- **Yosemite National Park**
- January
- February
- March
- April
- May
- June
- July

Legend

- **LakeTahoe**
- **CA_Outline**
- **Yosemite National Park**
- January
- February
- March
- April
- May
- June
- July

N

Miles
0 12.5 25 50

July to December Freezeline Dynamics: 1934 and 2004

1934

2004

Legend

- LakeTahoe
- CA_Outline
- Yosemite National Park
- December
- November
- October
- September
- August
- July

Legend

- LakeTahoe
- CA_Outline
- Yosemite National Park
- December
- November
- October
- September
- August
- July

N

Miles
0   12.5   25   50

January to June Freezeline Dynamics

July to December Freezeline Dynamics

Not Frozen By

- **August** (red)
- **September** (purple)
- **October** (yellow)
- **November** (blue)
- **December** (olive)
- **Lake Tahoe** (light blue)
- **CA Outline**
- **Yosemite NP**
- **Highway**
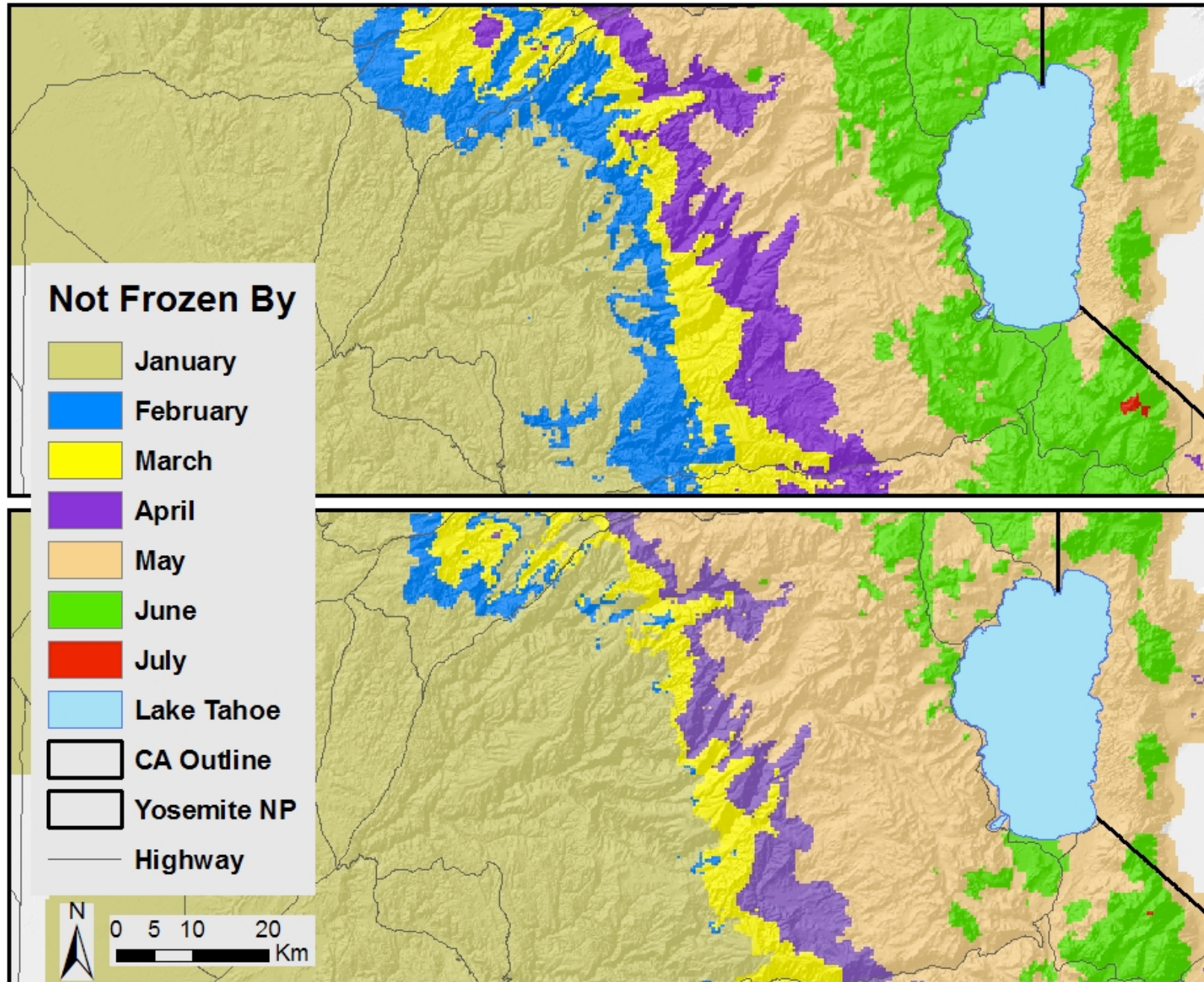
1905-1934

1970-2004

N

0 5 10   20
Km

January to June Freezeline Dynamics

Not Frozen By
- January
- February
- March
- April
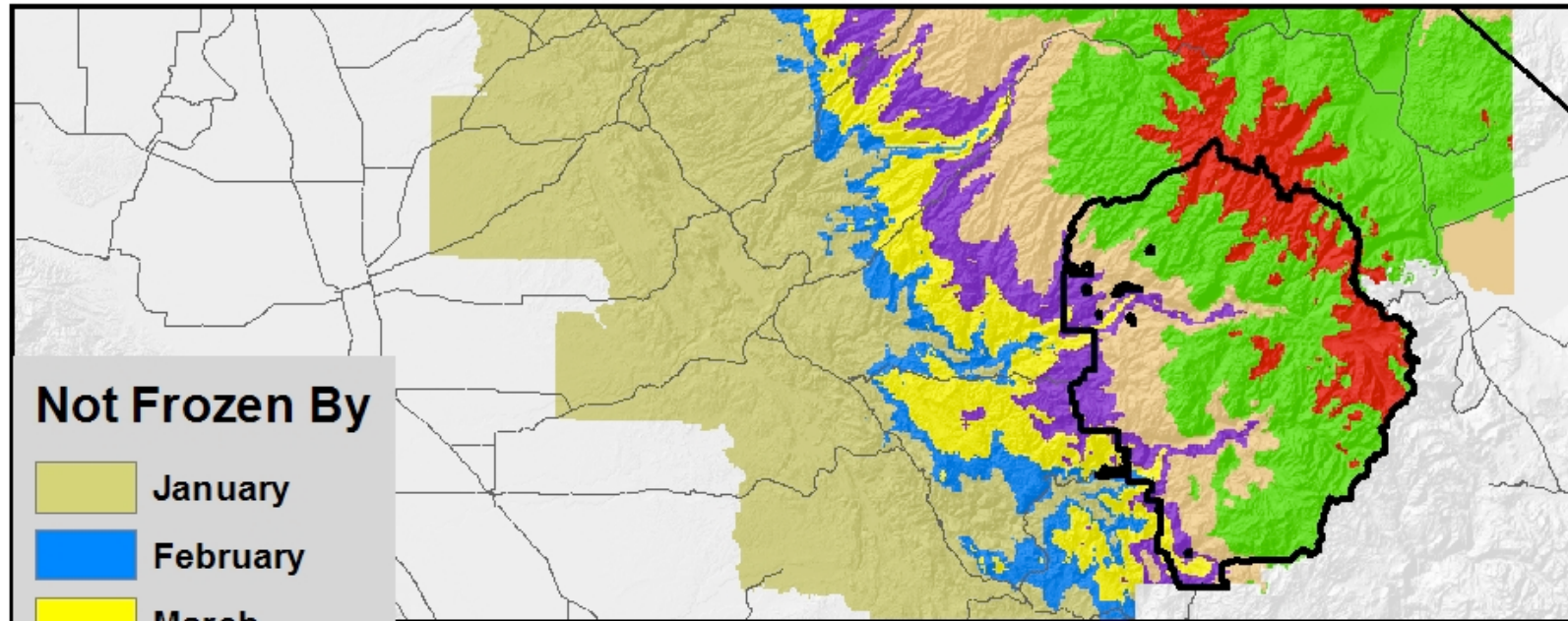- May
- June
- July
- CA Outline
- Yosemite NP
- Highway

1905-1934

1970-2004

0 5 10 20 Km

N
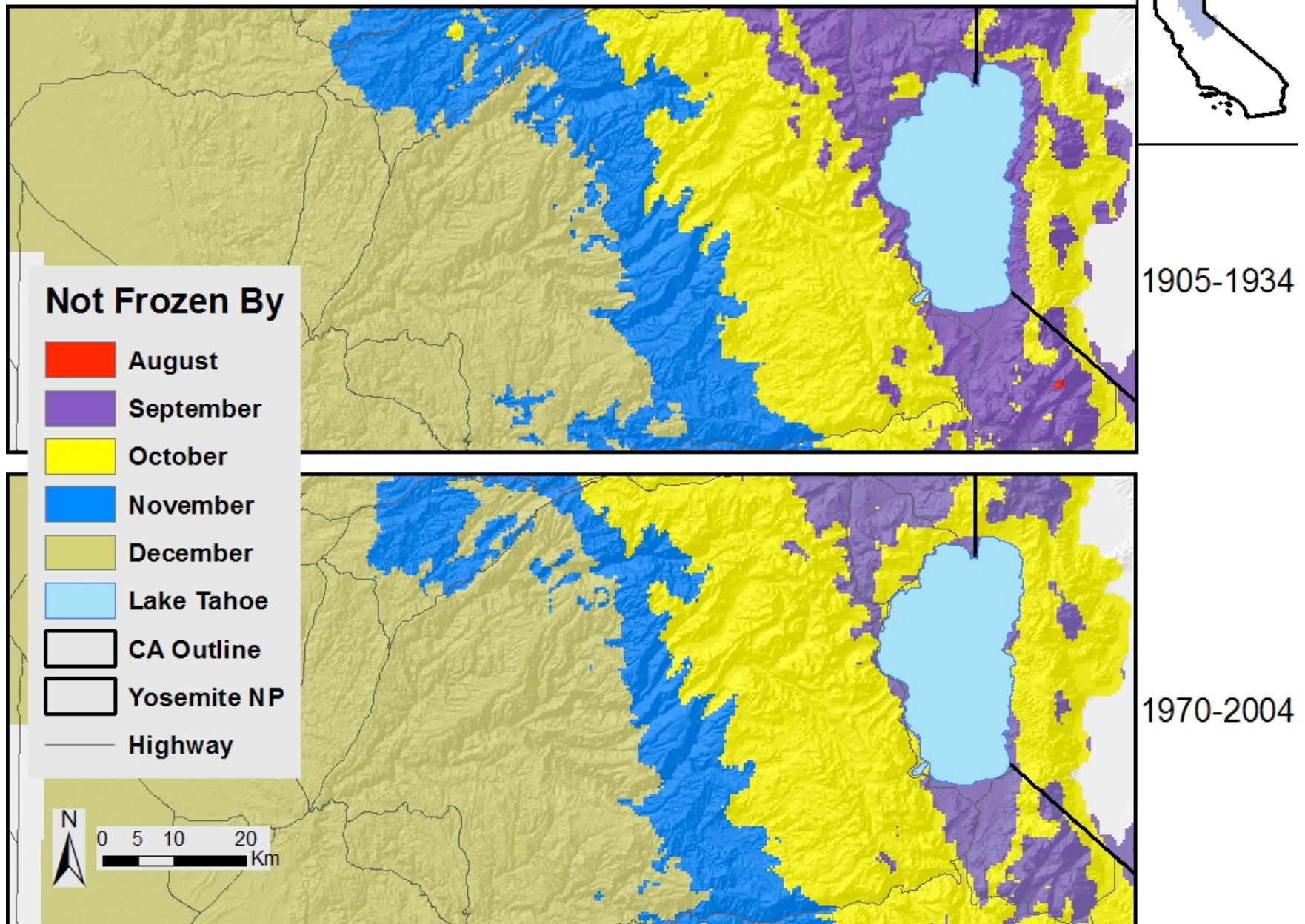
July to December Freezeline Dynamics

1905-1934

1970-2004

Not Frozen By
- August
- September
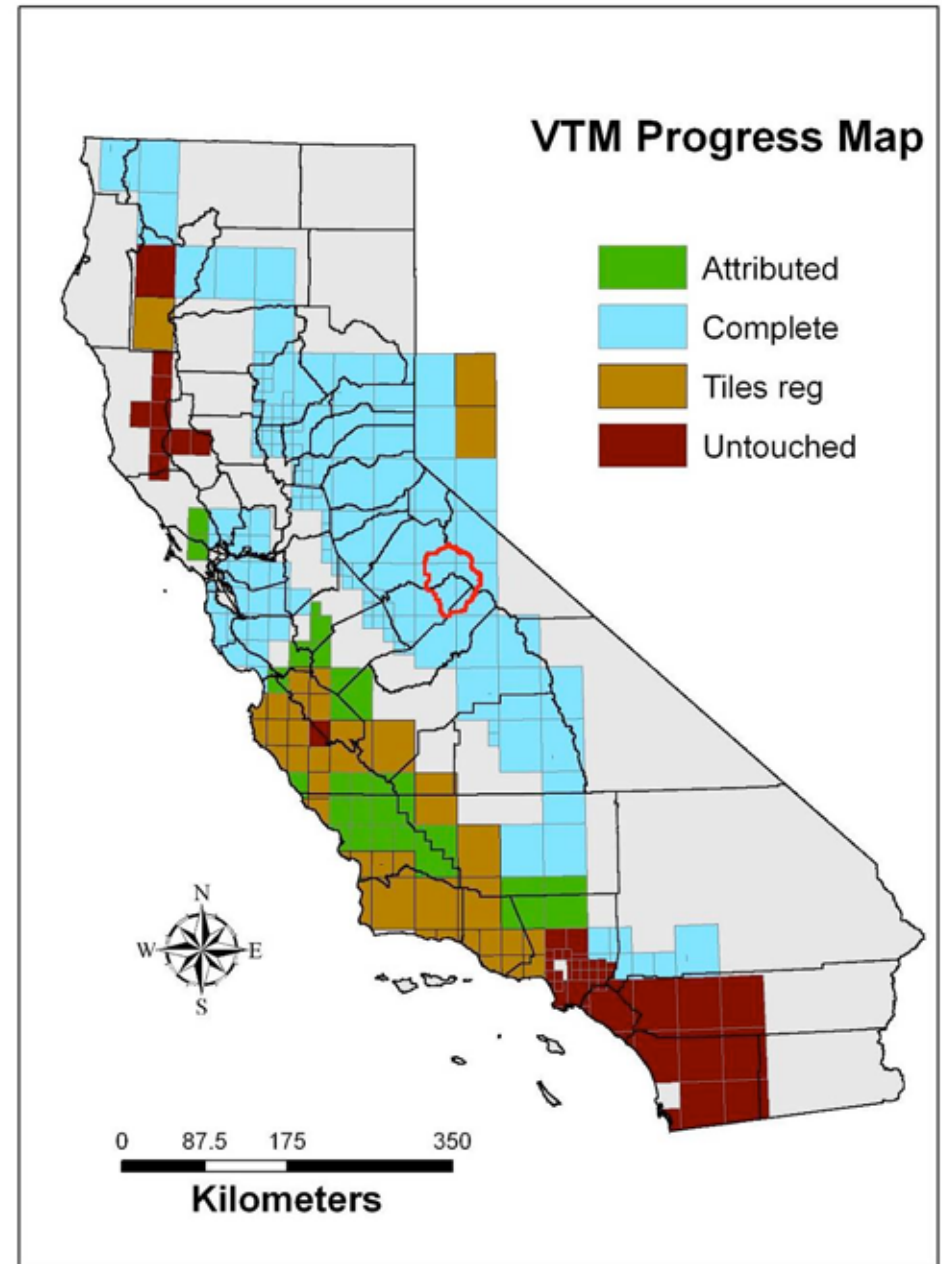- October
- November
- December
- CA Outline
- Yosemite NP
- Highway

N

0 5 10 20 Km
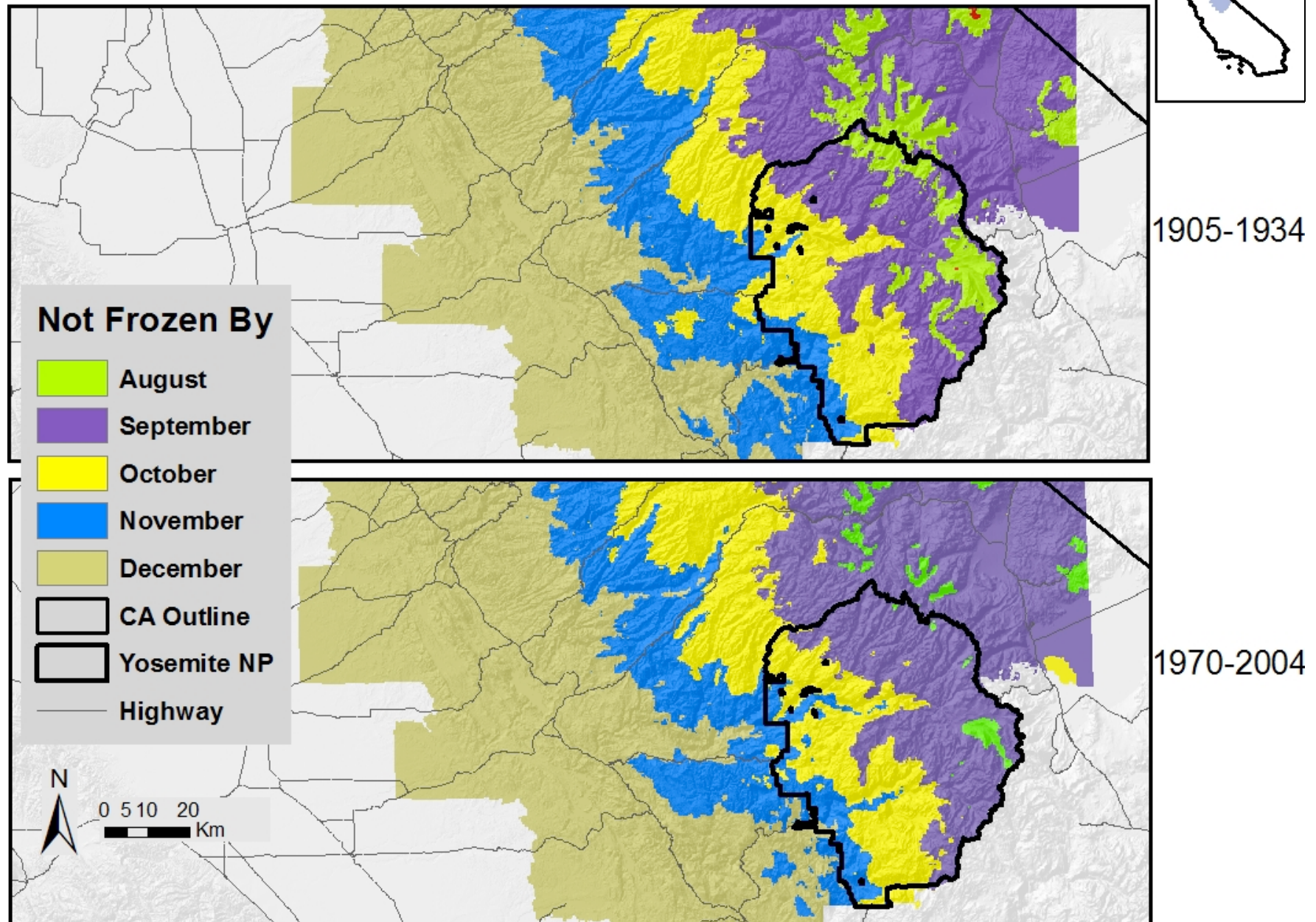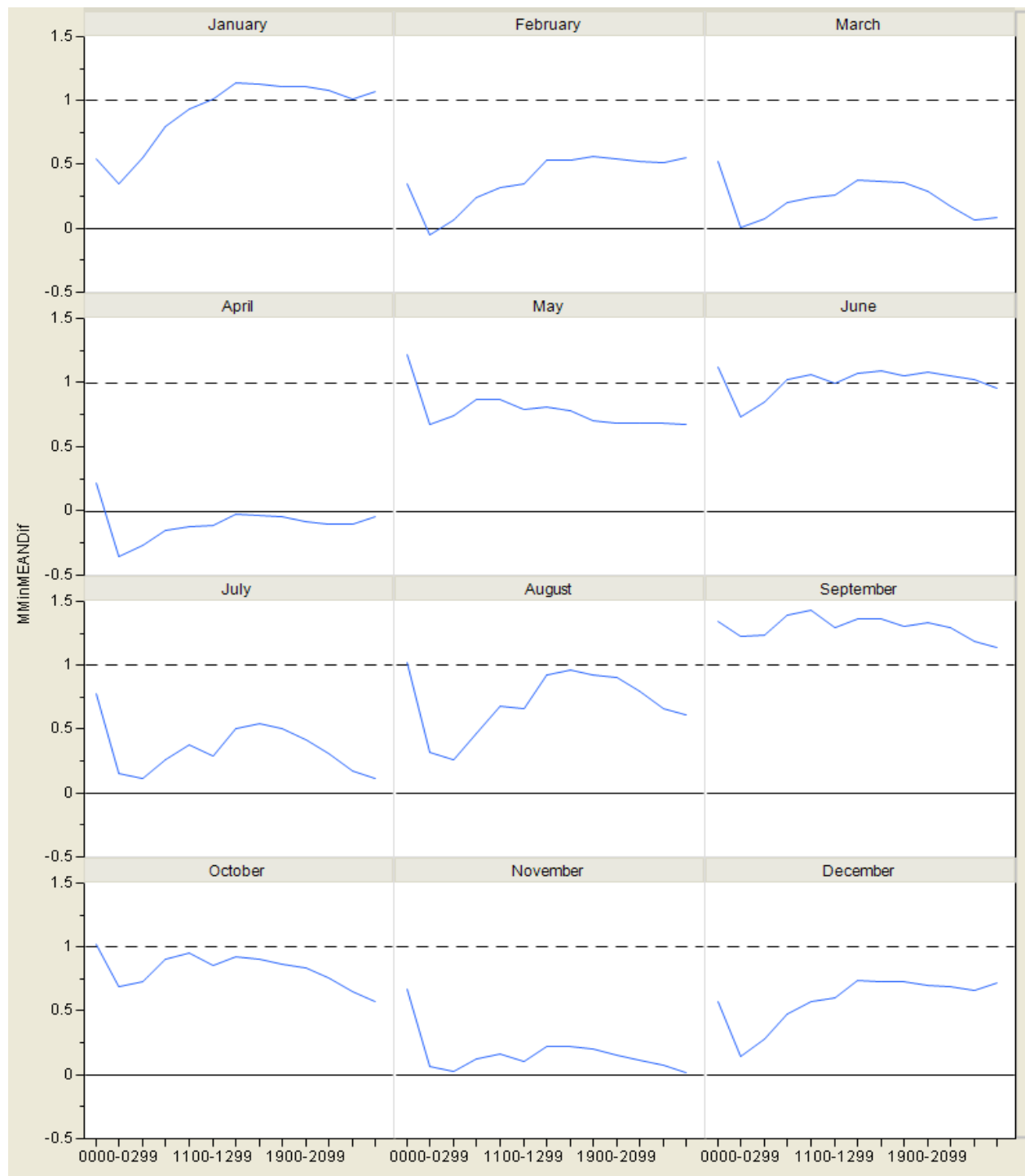
The Wieslander VTM Project
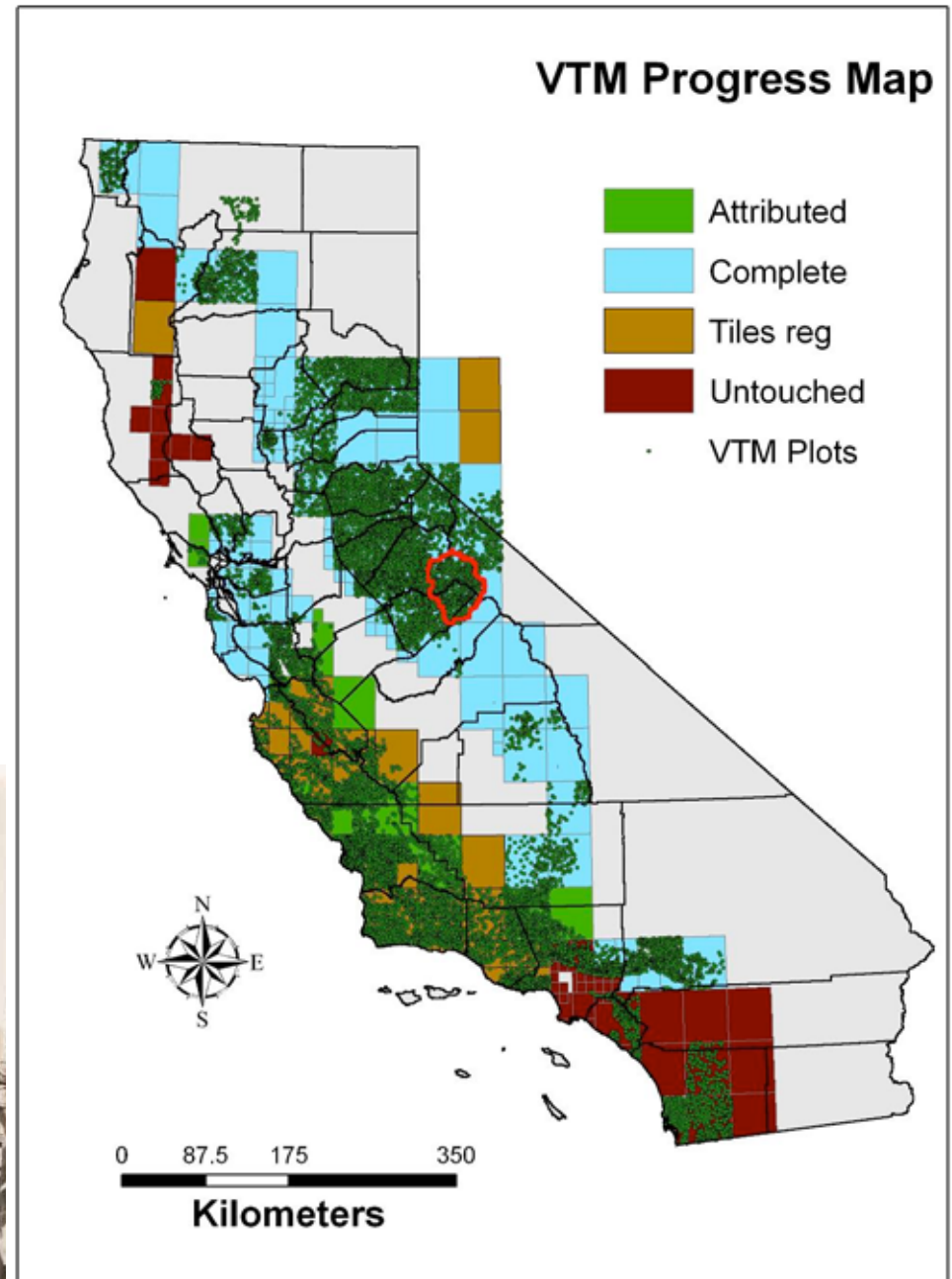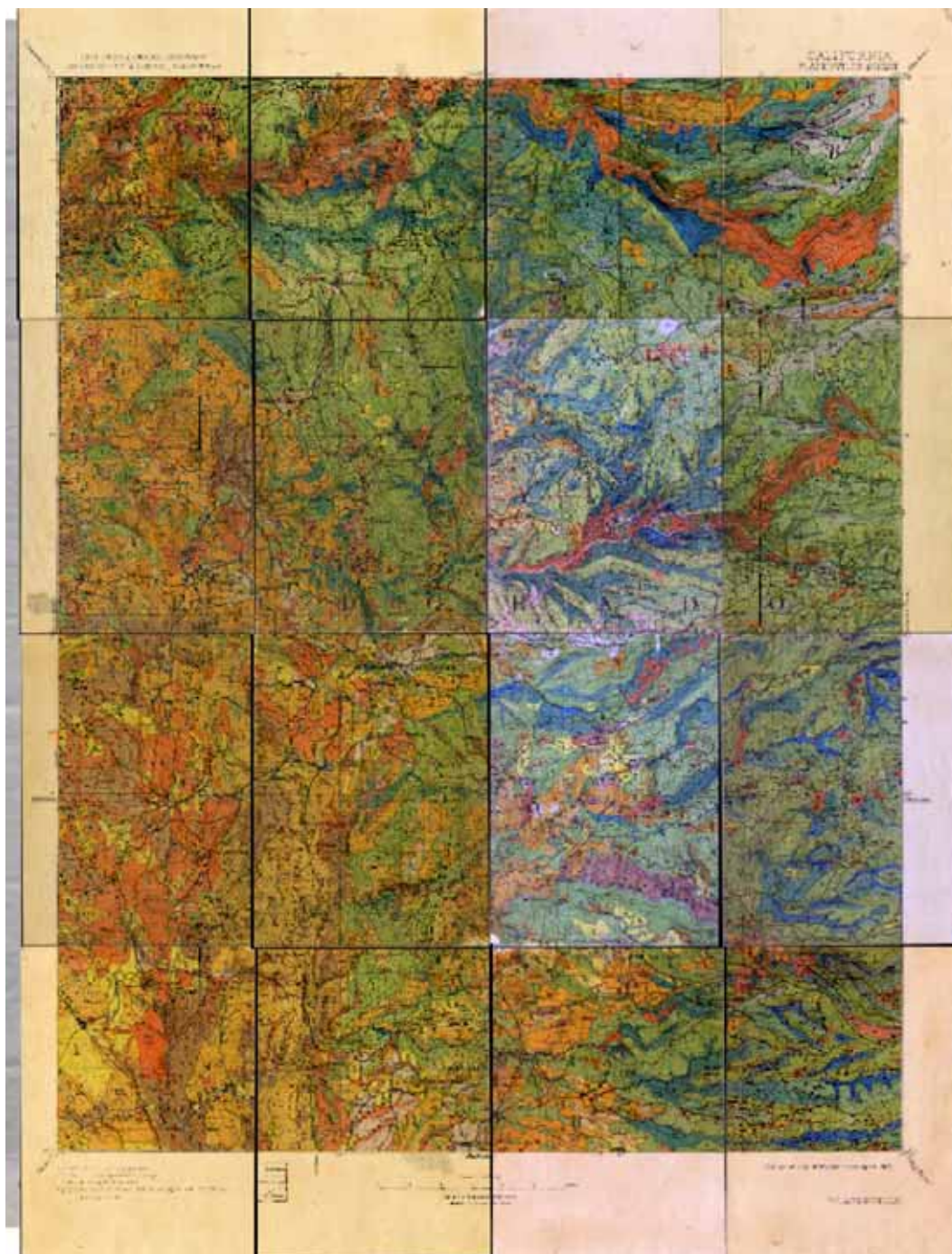
- Conducted in the 1930s

- Basis for much of current understanding of California Vegetation

- Surveyed Forested Regions of the State

The Wieslander VTM Project

- **Mapped 1/3 of the state**

- **16,000 vegetation plots**

- **Over 3000 photographs**

VTM Progress Map

- Attributed
- Complete
- Tiles reg
- Untouched
- VTM Plots

0   87.5   175   350

Kilometers

**VTMs
1934**

YD
B

YD
B
C

YD
B

CAv
ApcL
Ck

SYDl

SWI

SWI

SYW

SYD
B

SWI

B
Av
Cu

SYW

SWI

Canyon

Ap
Cco

SYW

B

SY
B

SWI

Ap
Cco

Wallace

Moore Wallace Canyon

4,500

SDW

SWI

Wallace Canyon

R

SW

SYW

SXW

SY

Creek

SYDW

Devil Peak

5340

5000

Gardners

YW
Ap Cco
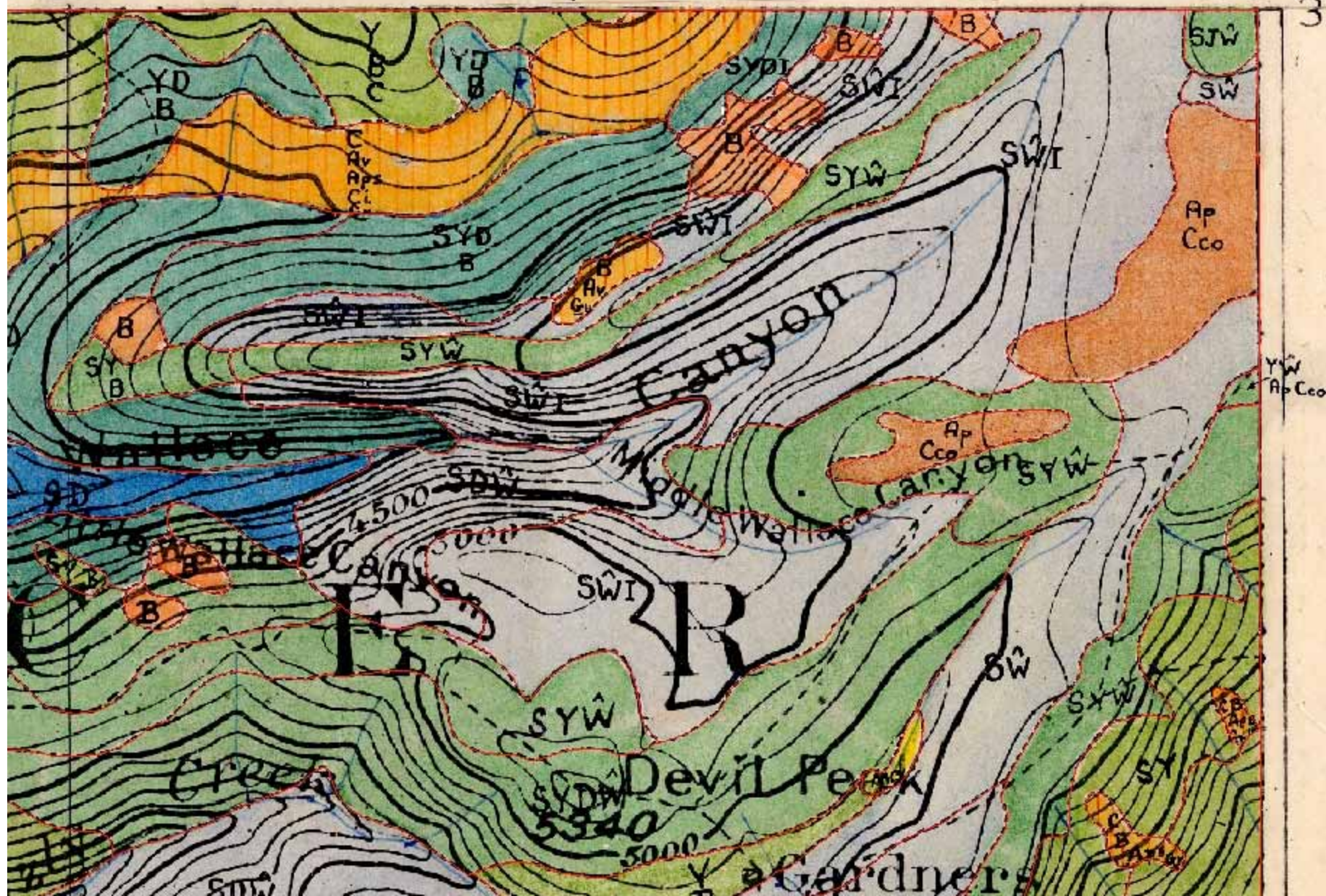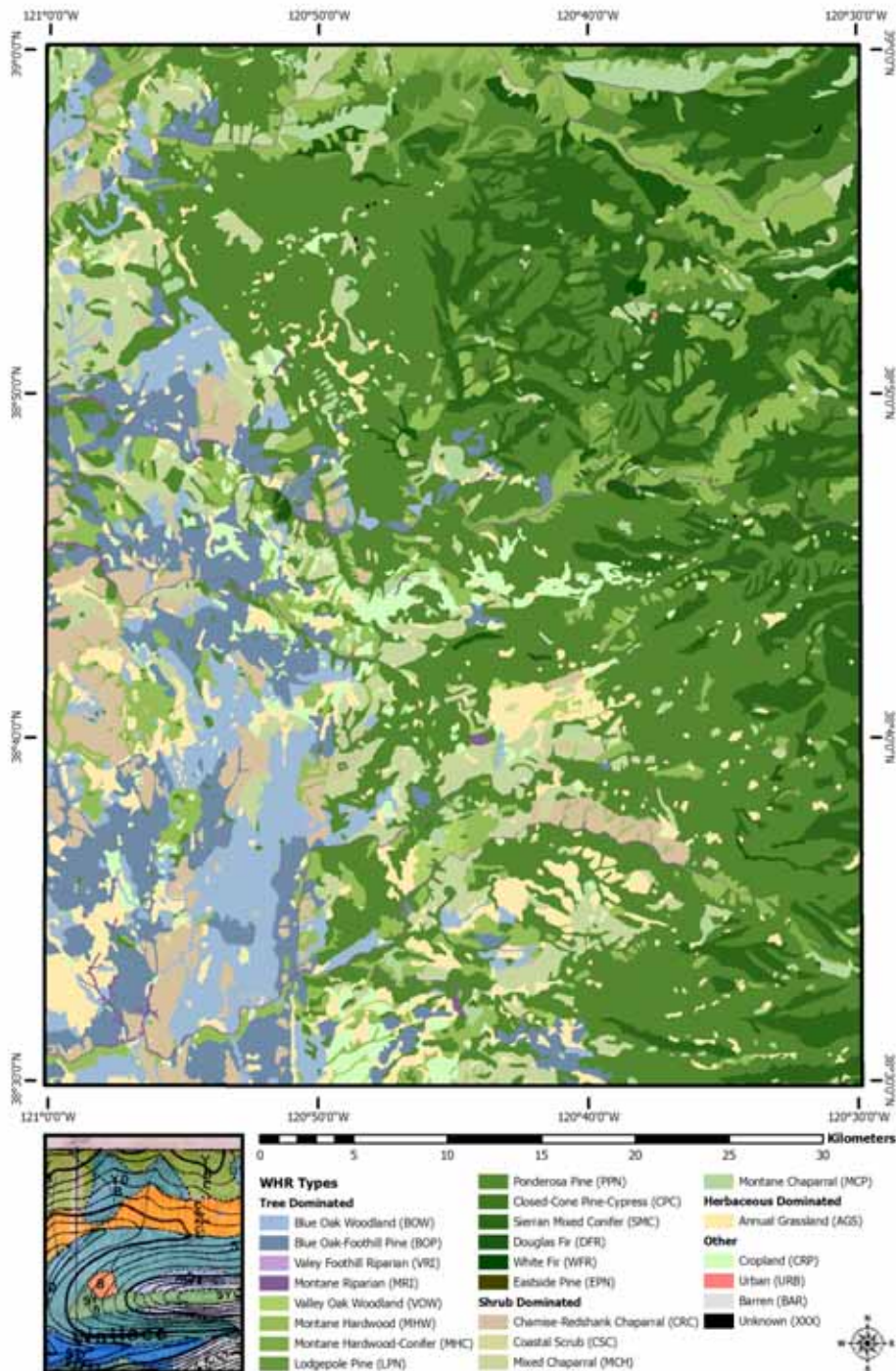
Fully converted VTM quad

**Can be queried by species
or vegetation type**

**Species combinations
Were converted to**

**California
Wildlife Habitat Relationships-**

**a habitat classification that
names certain species**

Study Area
Central &
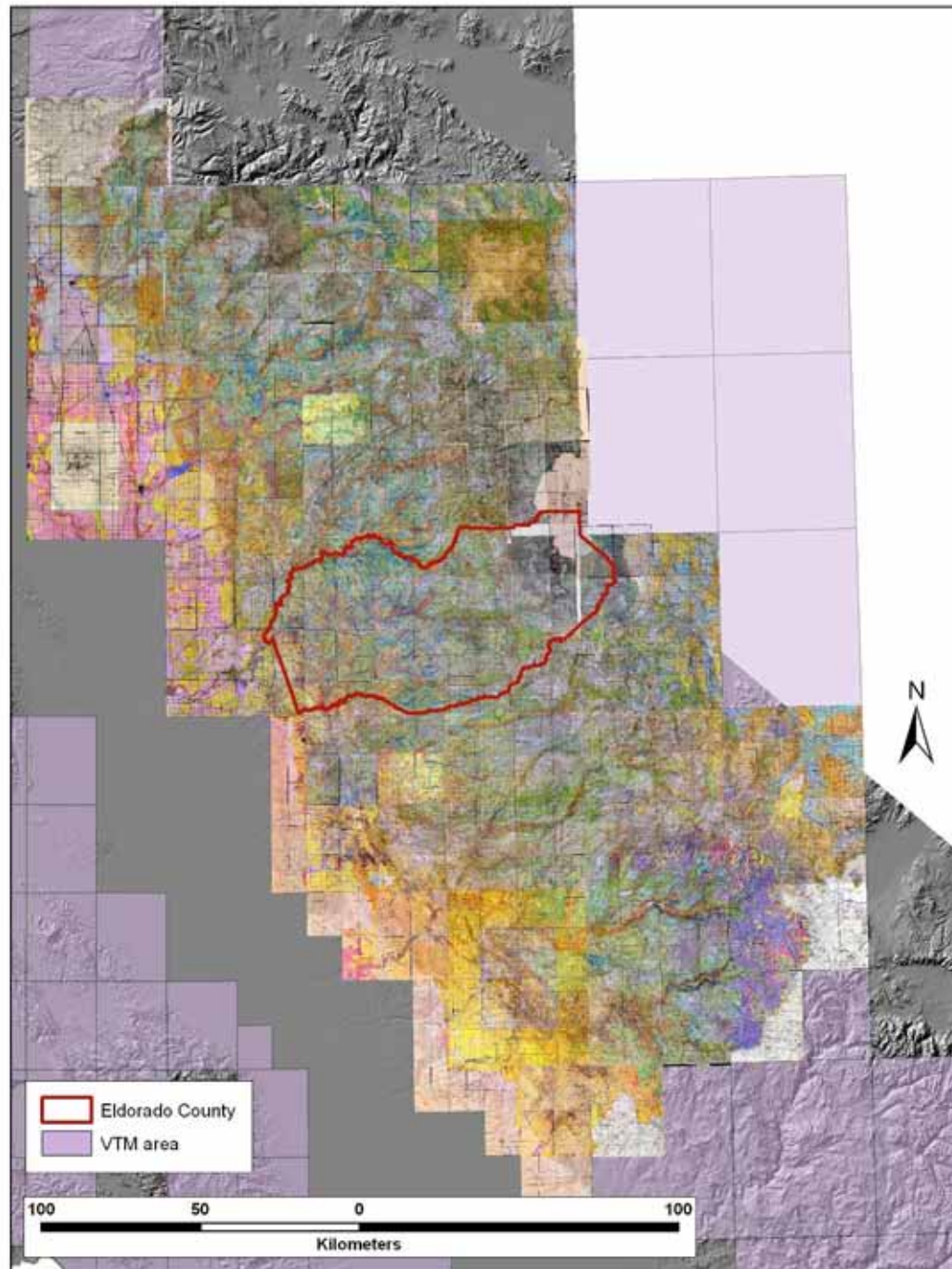**Northern**
Sierra

Analytical framework
development

Eldorado County
VTM area

100   50   0   100
Kilometers

Central Sierra 300-meter Grid

LAKE
TAHOE

FOLSOM
LAKE

Sierra Grid
Forest Boundary
Watershed Boundary
Highway

10 5 0   10 Kilometers
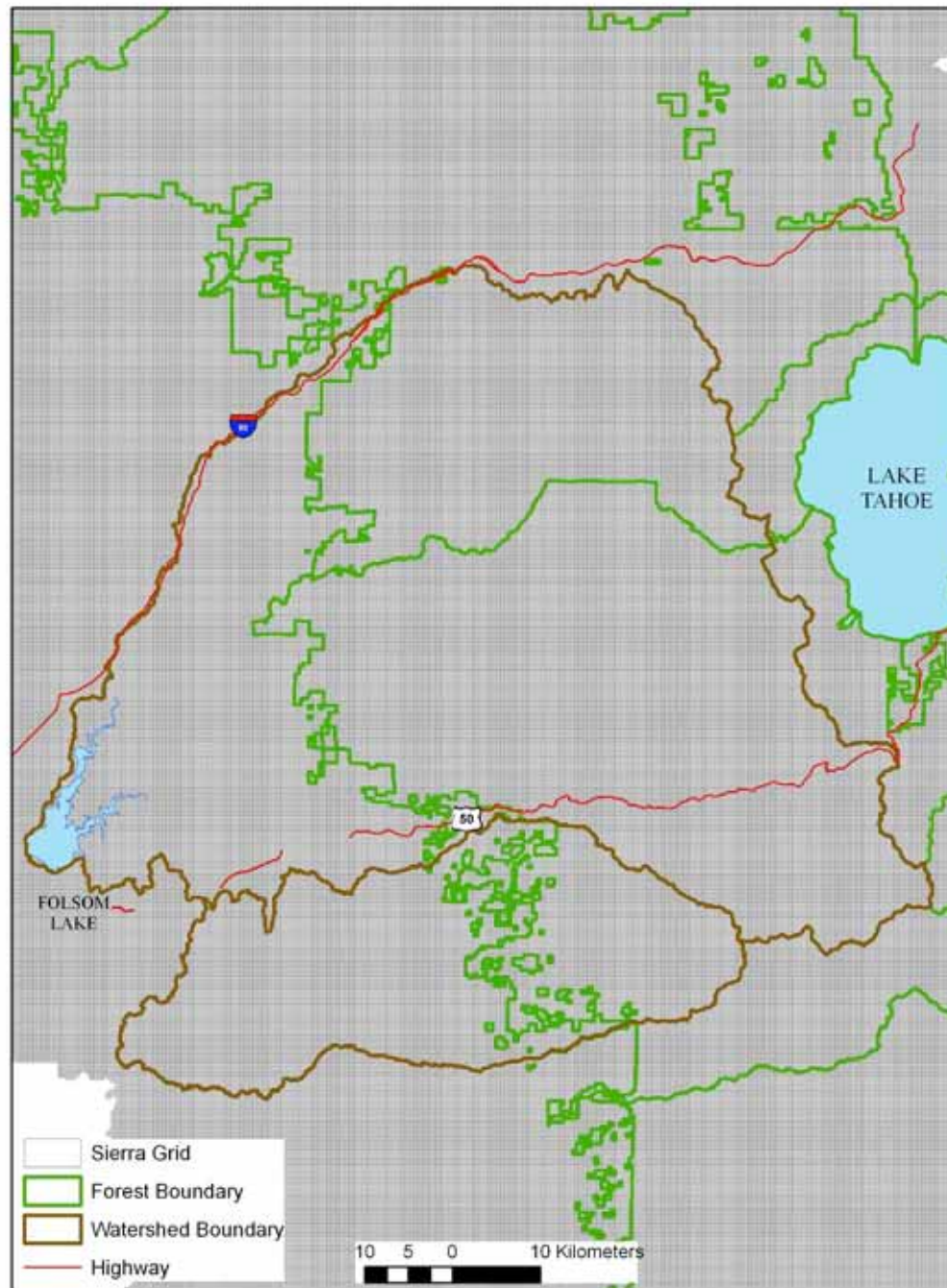
Construction of landscape analysis framework:

For every cell add:

Dominant Vegetation T1, T2
Weather Data T1, T2
Environmental variables
  e.g. topographic roughness
      aspect
      slope
      solar radiation
      geology
      # of fires

Climate data from 800m
 PRISM dataset

Western Slope of the Sierra

Eastern Slope of the Sierra

12,000'

10,000'

8,000'

6,000'

4,000'

2,000'

300'

FOX TAIL PINE

WHITEBARK PINE

FOXTAIL PINE

WESTERN WHITE PINE

WHITEBARK PINE

LIMBER PINE

LODGEPOLE PINE

MTN. HEMLOCK

MTN. HEMLOCK

LODGEPOLE PINE

QUAKING ASPEN

QUAKING ASPEN

RED FIR

WESTERN JUNIPER

ROCKY CLIFFS

WESTERN JUNIPER

RED FIR

JEFFREY PINE

WHITE FIR

JEFFREY PINE

GIANT SEQUOIA

STREAMSIDE TREES

BITTER CHERRY

MTN. MAHOGANY

WHITE FIR

BLACK OAK

WATER BIRCH

LIVE OAK

SINGLE-LEAF PINYON

SUGAR PINE

DOGWOOD

DOUGLAS FIR

TREES OF STREAMSIDE & NARROW CANYONS

DESERT ASH

COTTONWOODS

WHITE ALDER

CALIF. TORREYA

WILLOWS

BLACK OAK

INCENSE CEDAR

BIG LEAF MAPLE

'SINGLE-LEAF PINYON (ON FEW CANYON WALLS)

DESERT BASINS

PONDEROSA PINE

OREGON ASH

CALIF. LAUREL

"Profile of the Southern Sierra Nevada showing a typical distribution of the tree species."

KNOBCONE PINE

DIGGER PINE

CALIF. BUCKEYE

BLACK COTTONWOOD

LIVE OAK

BLUE OAK

CALIF. SYCAMORE

WILLOWS

WHITE OAK

GREAT CENTRAL VALLEY

Historic WHR Types

Current WHR Types

Legend:
- AGS
- BOP; BOW
- MHC; MHW
- PPN
- DFR; JPN; SMC; WFR
- LPN; RFR
- SCN
- EPN
- Lake Tahoe
- Study Boundary
- CA Outline

N

Kilometers
0   40   80
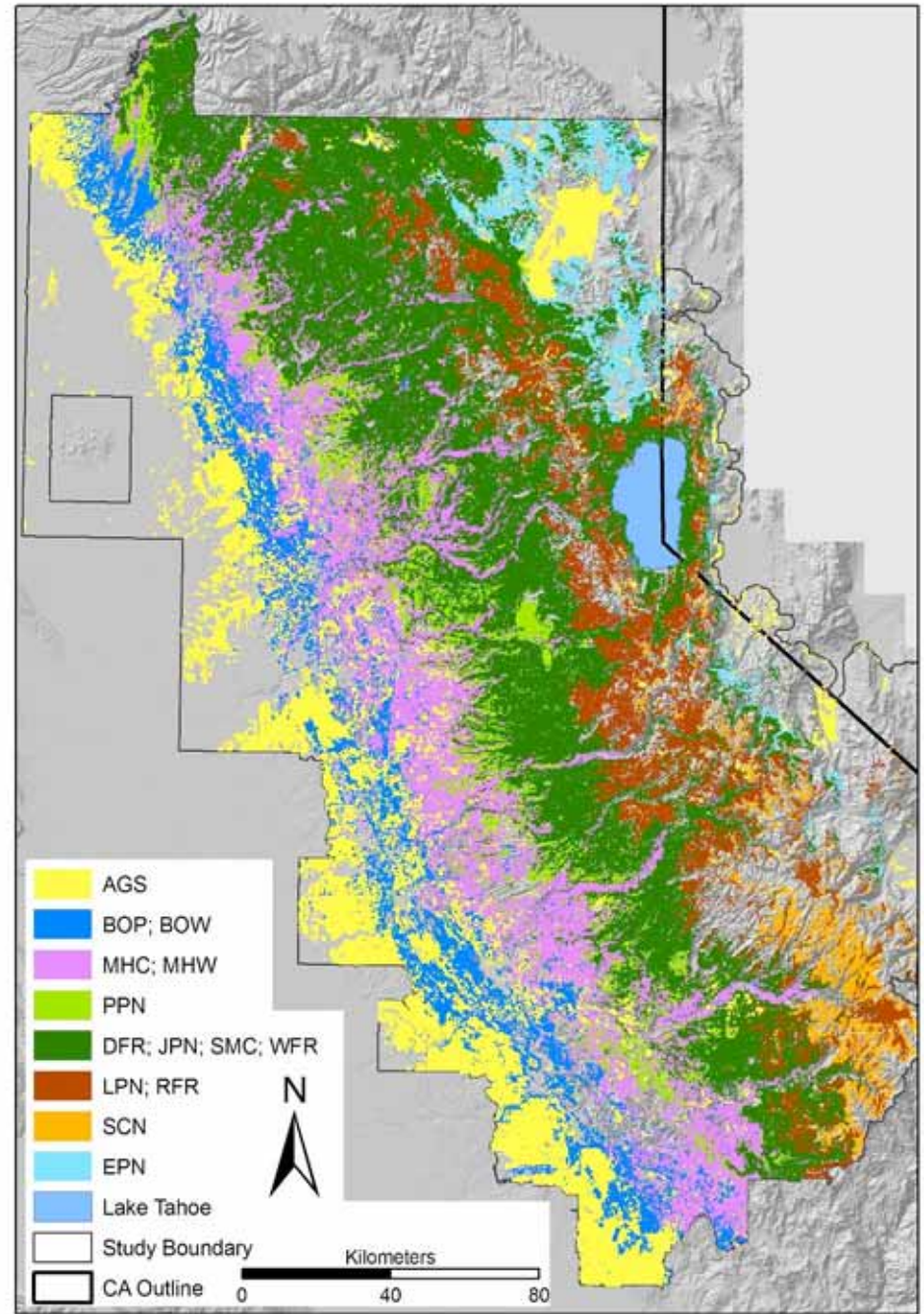
Winners

Wildlife Habitat Relationships	Historic Area (km2)	Current Area (km2)	Difference (km2)
Sierra Mixed Conifer	2,631	8,096	5,464
Annual Grassland	4,188	5,710	1,522
Montane Hardwood Conifer	47	1,496	1,449
Urban	57	1,382	1,324
Montane Hardwood	2,651	3,926	1,275

Losers

Agriculture	4,020	3,133	(887)
Blue Oak Foothill Pine	4,078	3,039	(1,038)
Jeffery Pine	3,703	561	(3,141)
Ponderosa Pine	5,662	1,752	(3,909)

WHR Type	Elevation Change vs Time (m)	Elevation Change vs Latitude (m)	t value - Time	t value - Lat	p value - Time	p value - Lat
UPPER EDGE						
Ponderosa Pine	-381.4	-75.8	33.06	-8.32	0	0
Montane Hardwood	15.9	-15.9	-1.16	-1.16	0.25	0.25
LOWER EDGE						
Sierra Mixed Conifer	-180.8	-192.9	17.14	-26.11	0	0
Ponderosa Pine	116.2	-131.1	-19.8	-21.07	0	0
Montane Hardwood	-10	-28.3	1.88	-4.15	0.06	0

Legend (left map):
- VTM Plot Locations
- Jepson Ecoregions

0   250   500
Kilometers

Legend (right map):
- Modern Vegetation Plot Locations
- Jepson Ecoregions
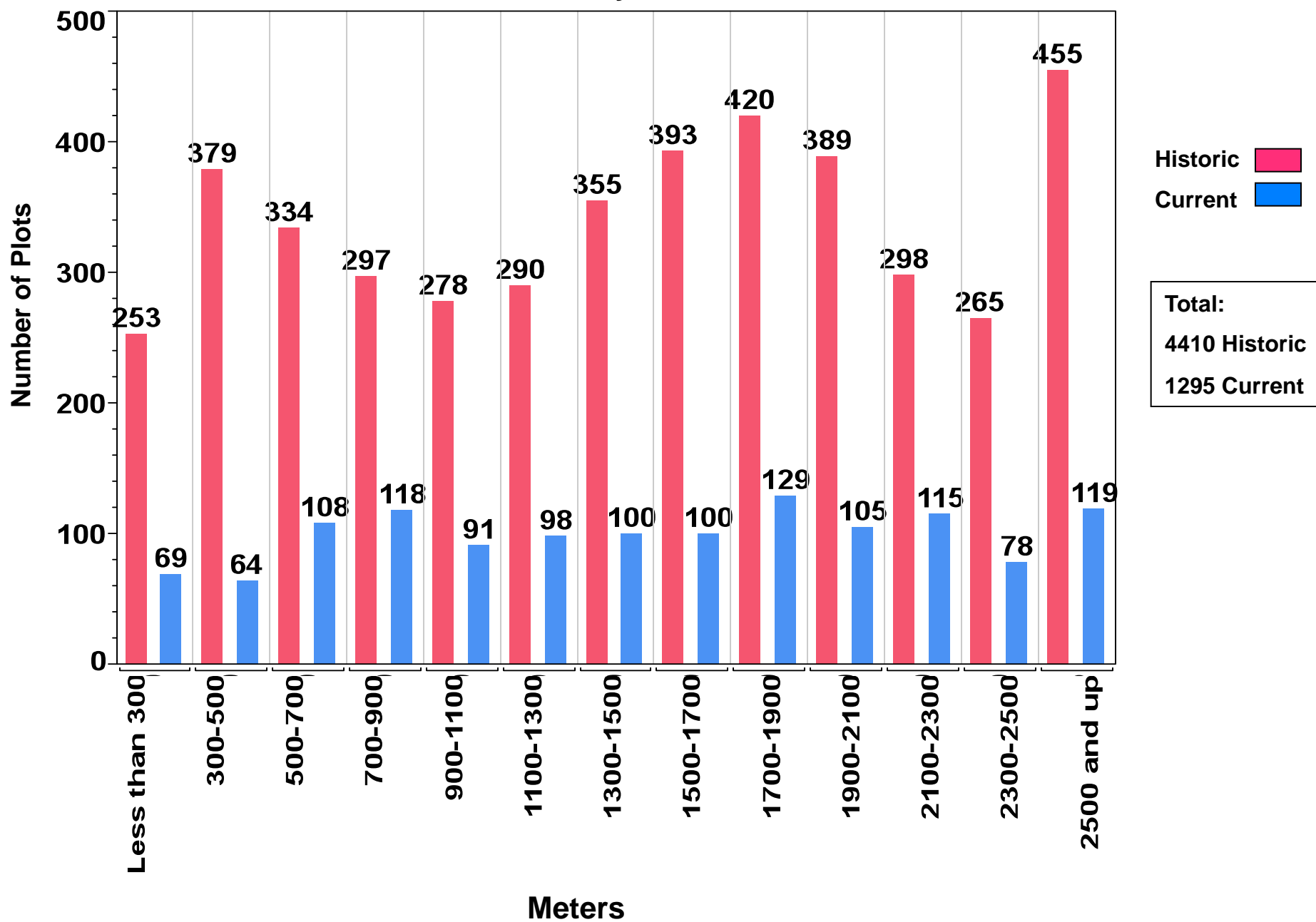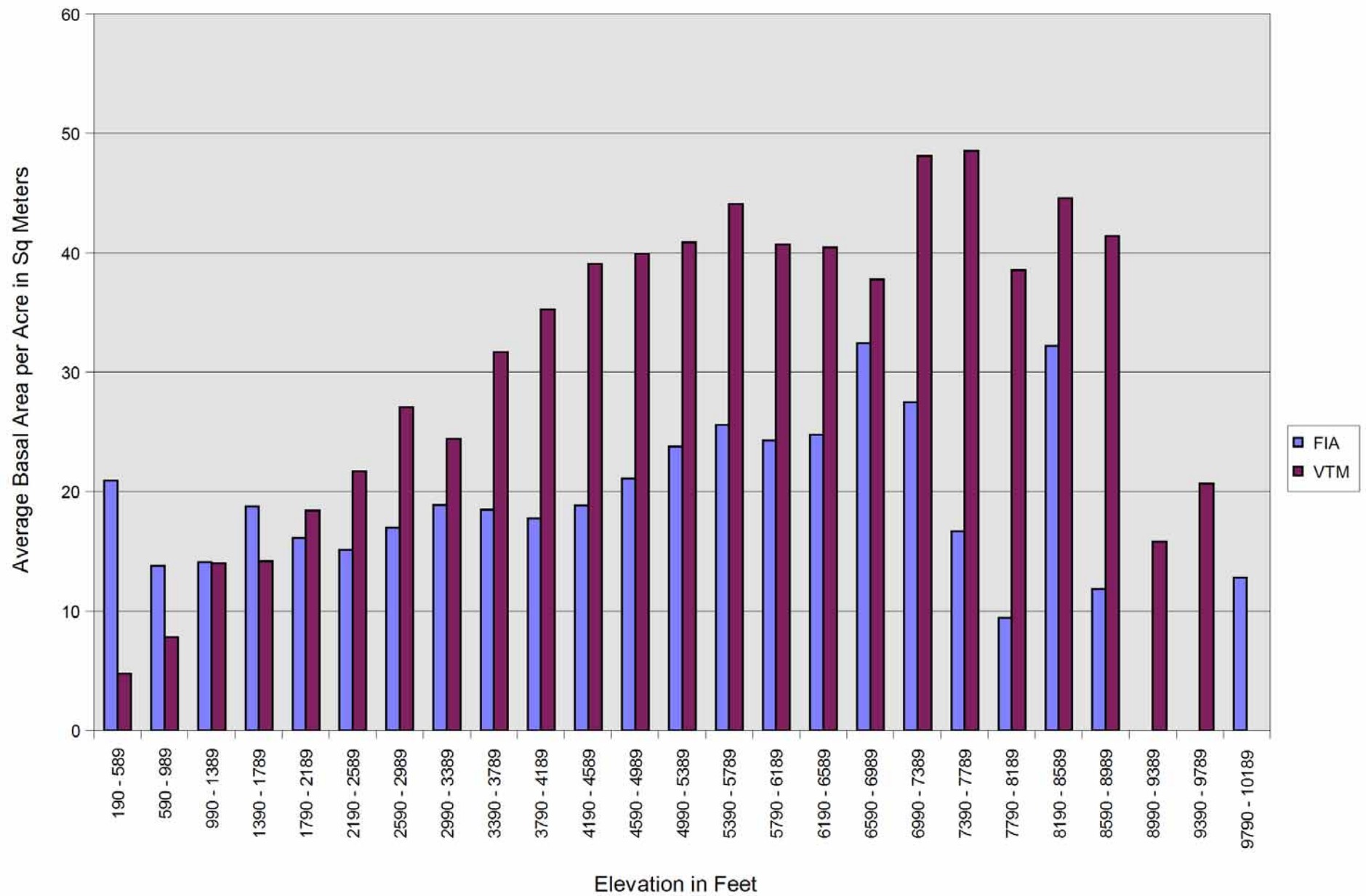
0   250   500
Kilometers
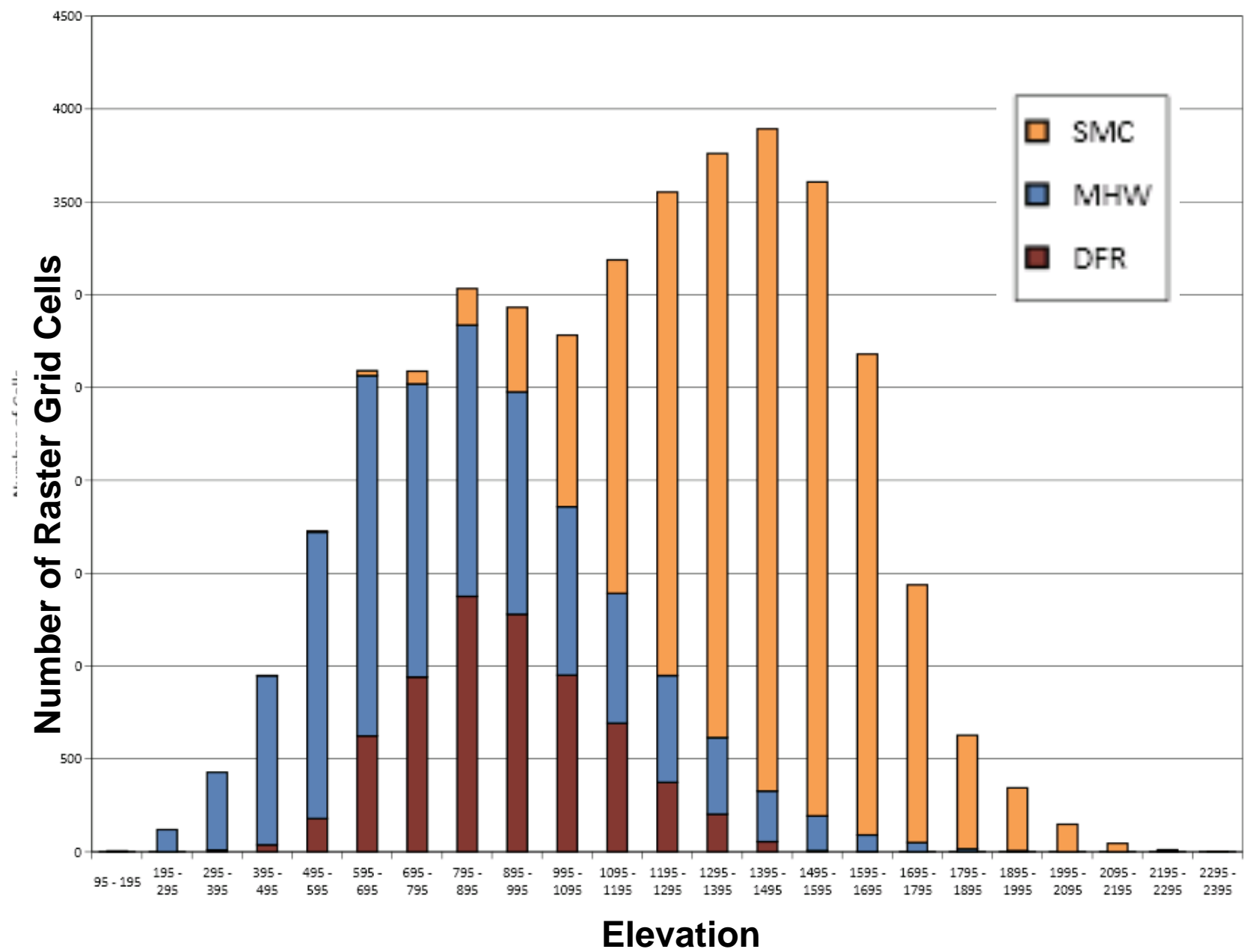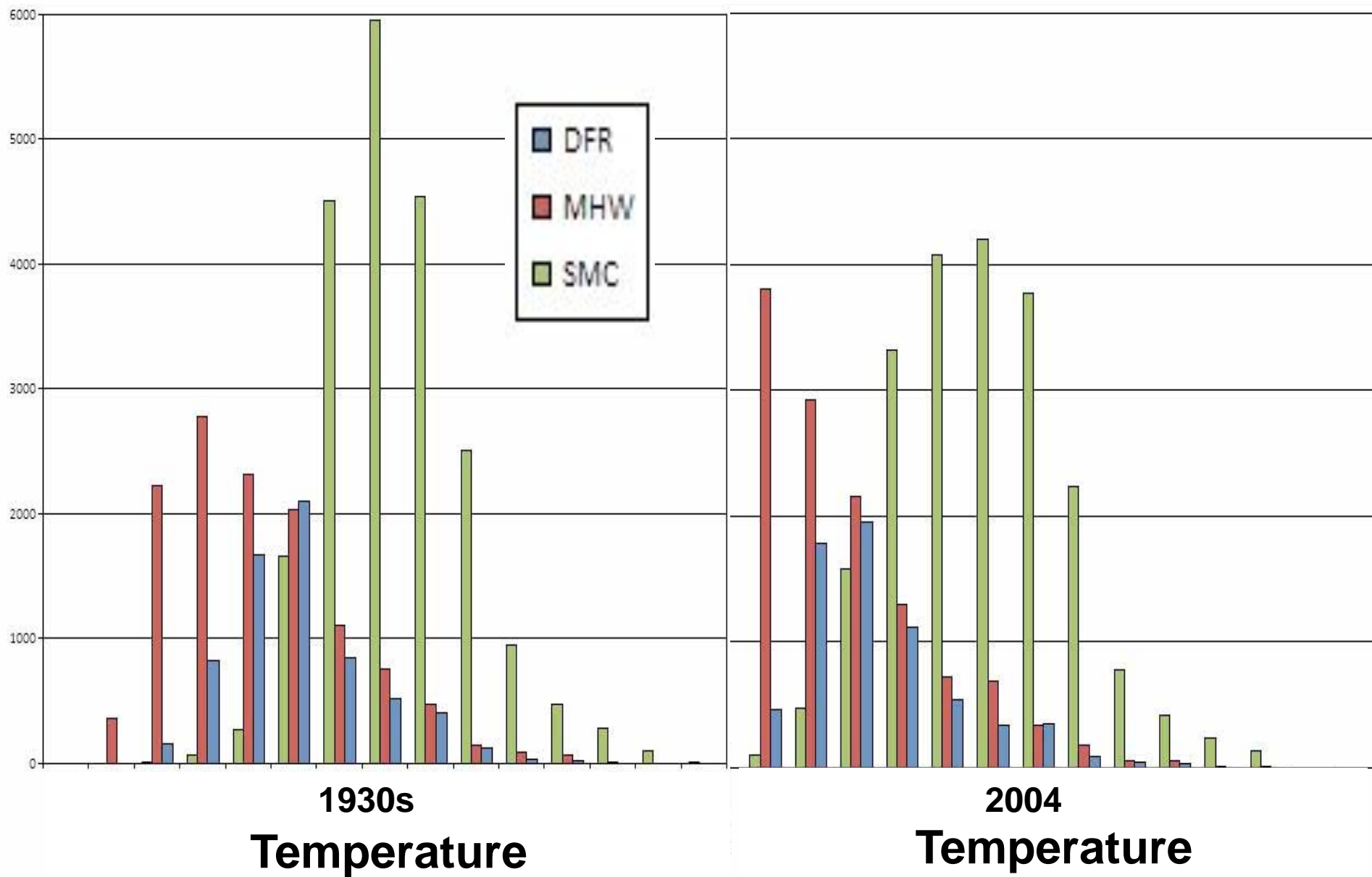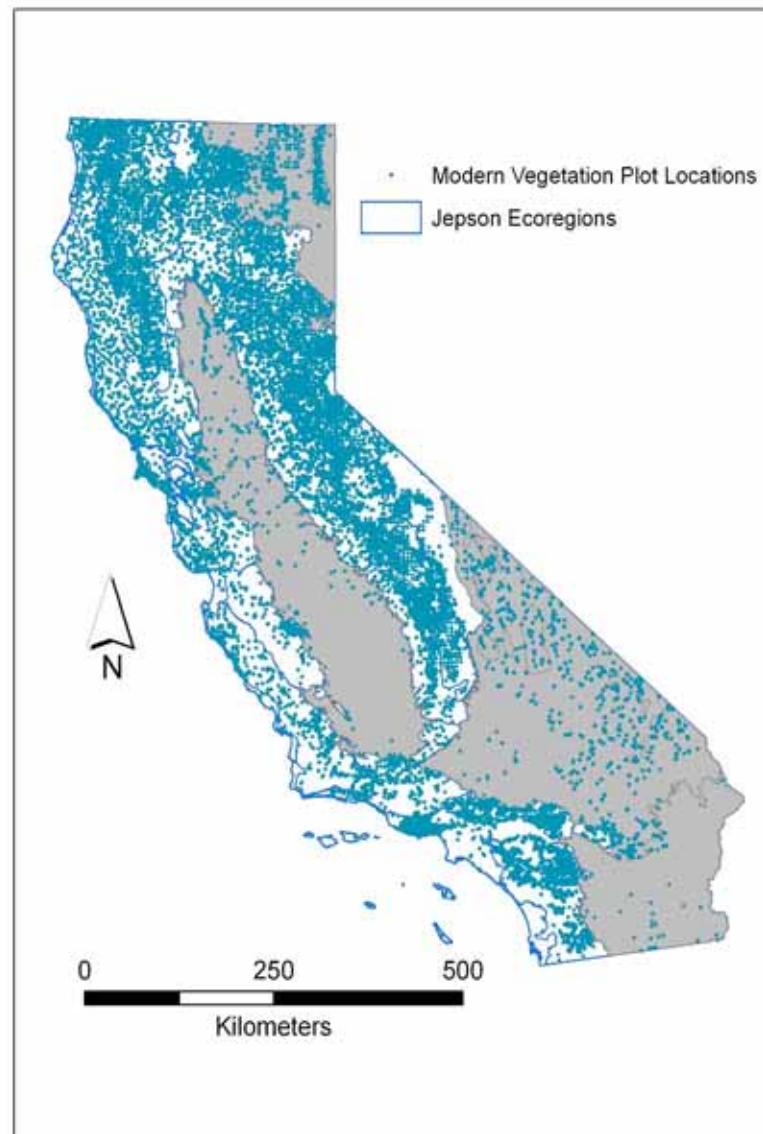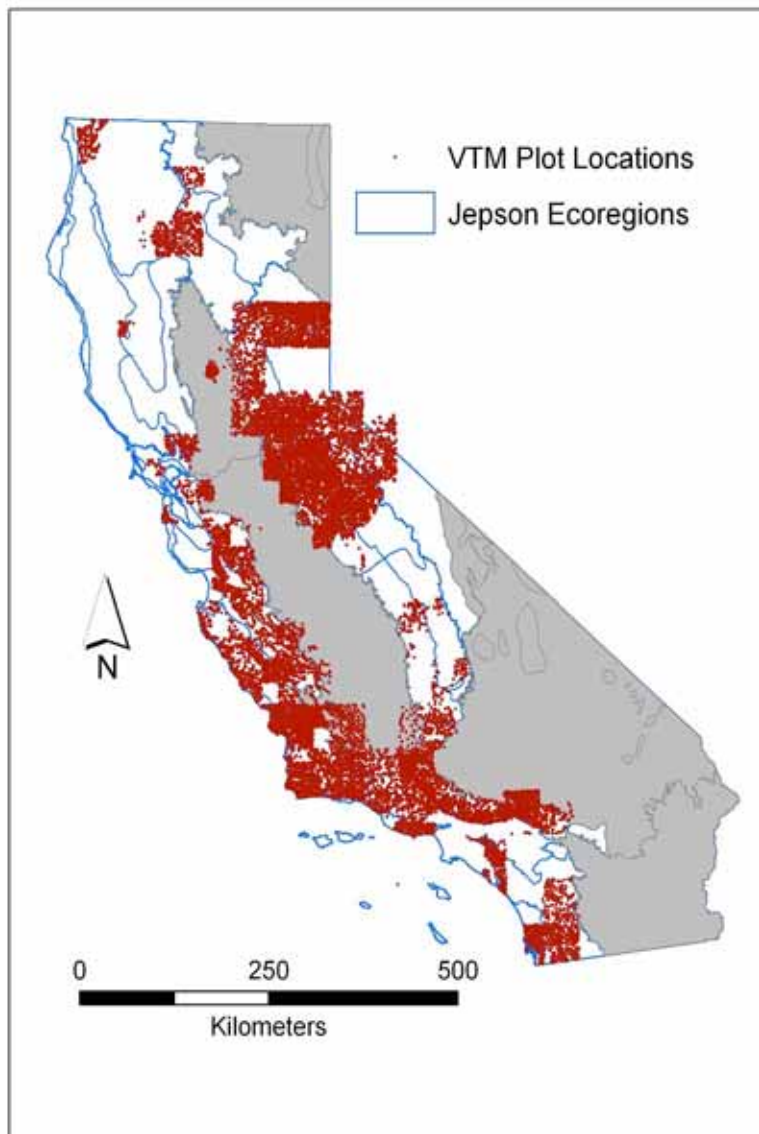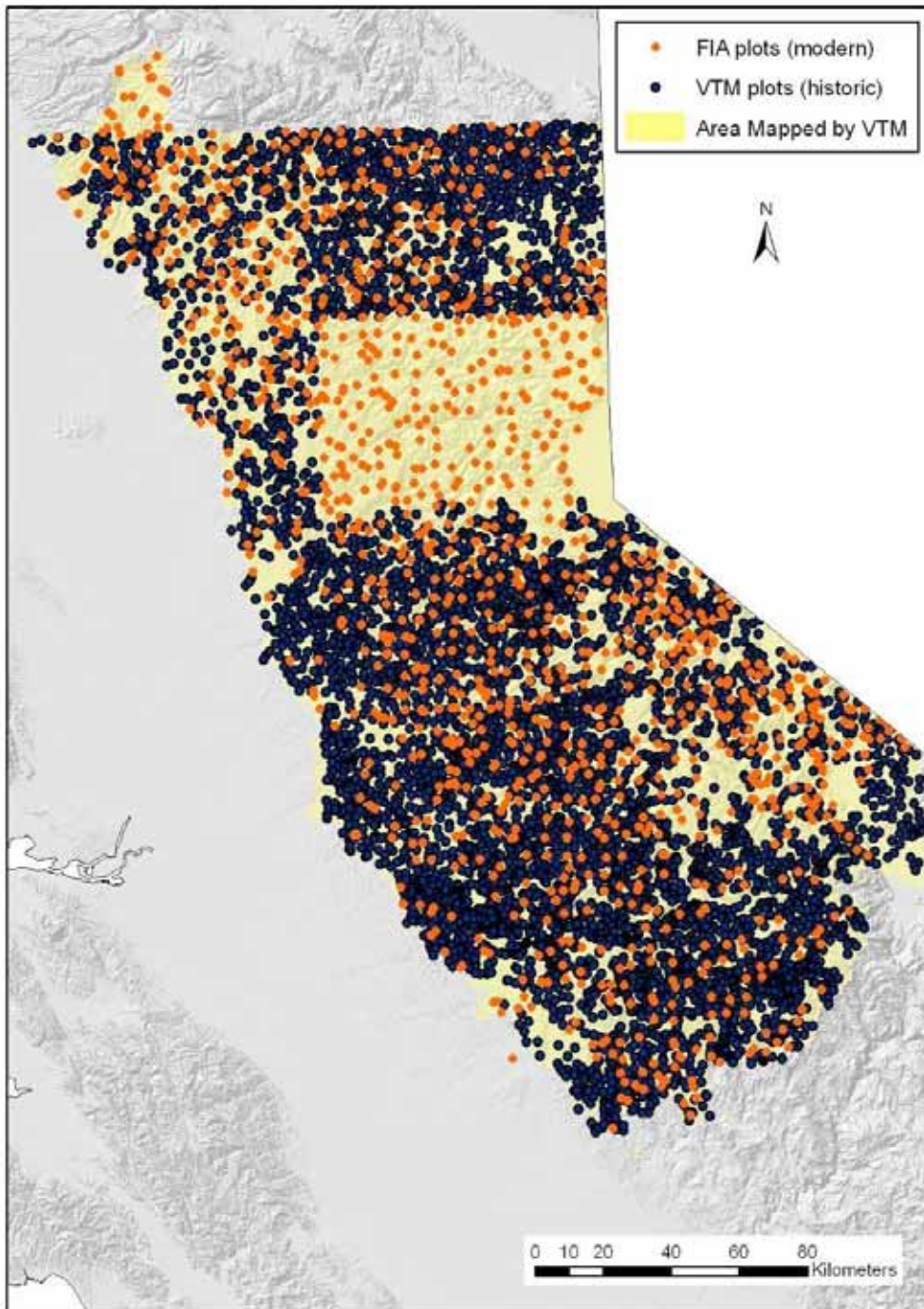
Total:
4410 Historic
1295 Current

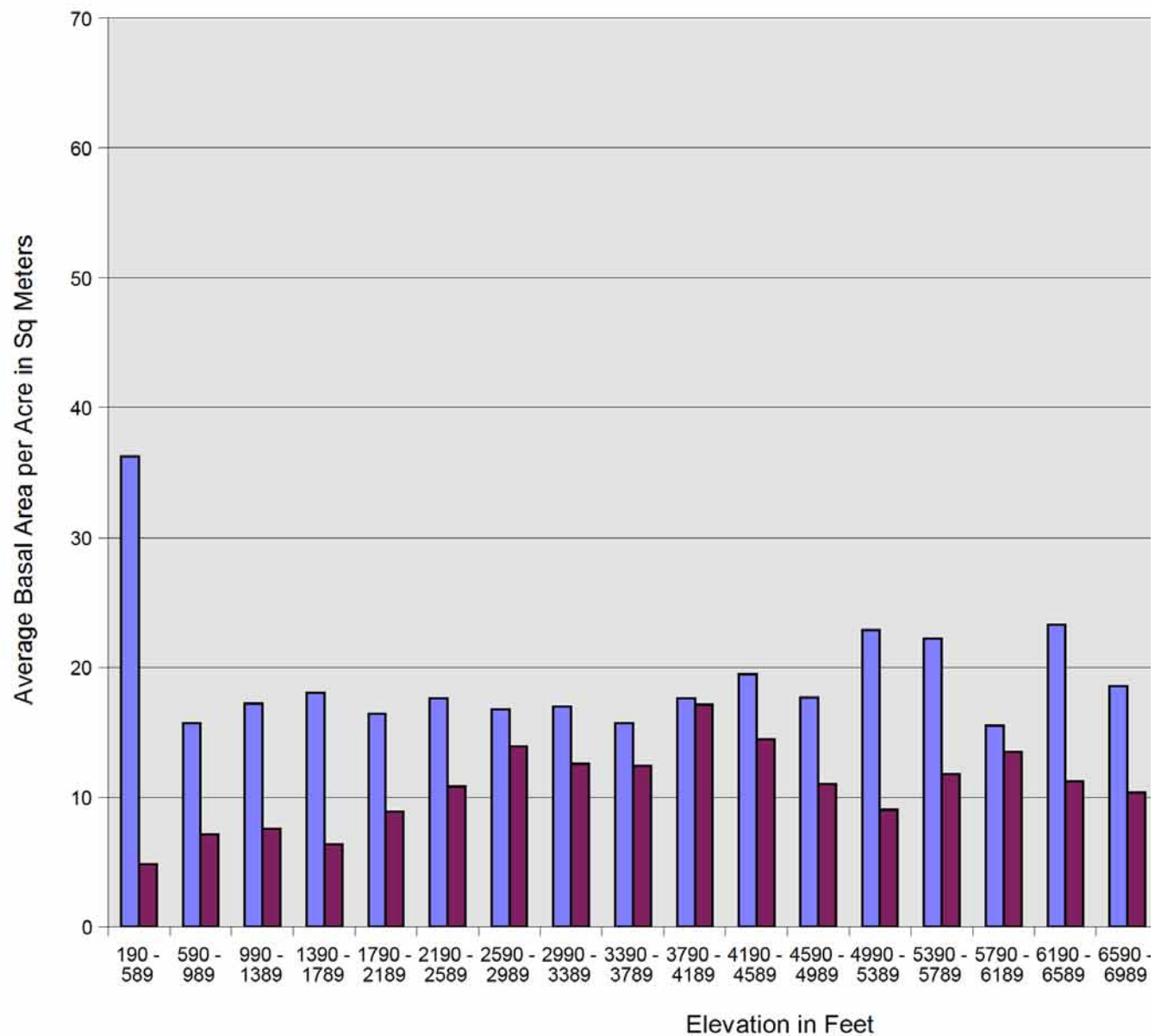**Combining plot data to the analysis offers the chance to examine changes in forest structure over time.**

Number of Plots by Elevation

Historic
Current

Total:
4410 Historic
1295 Current

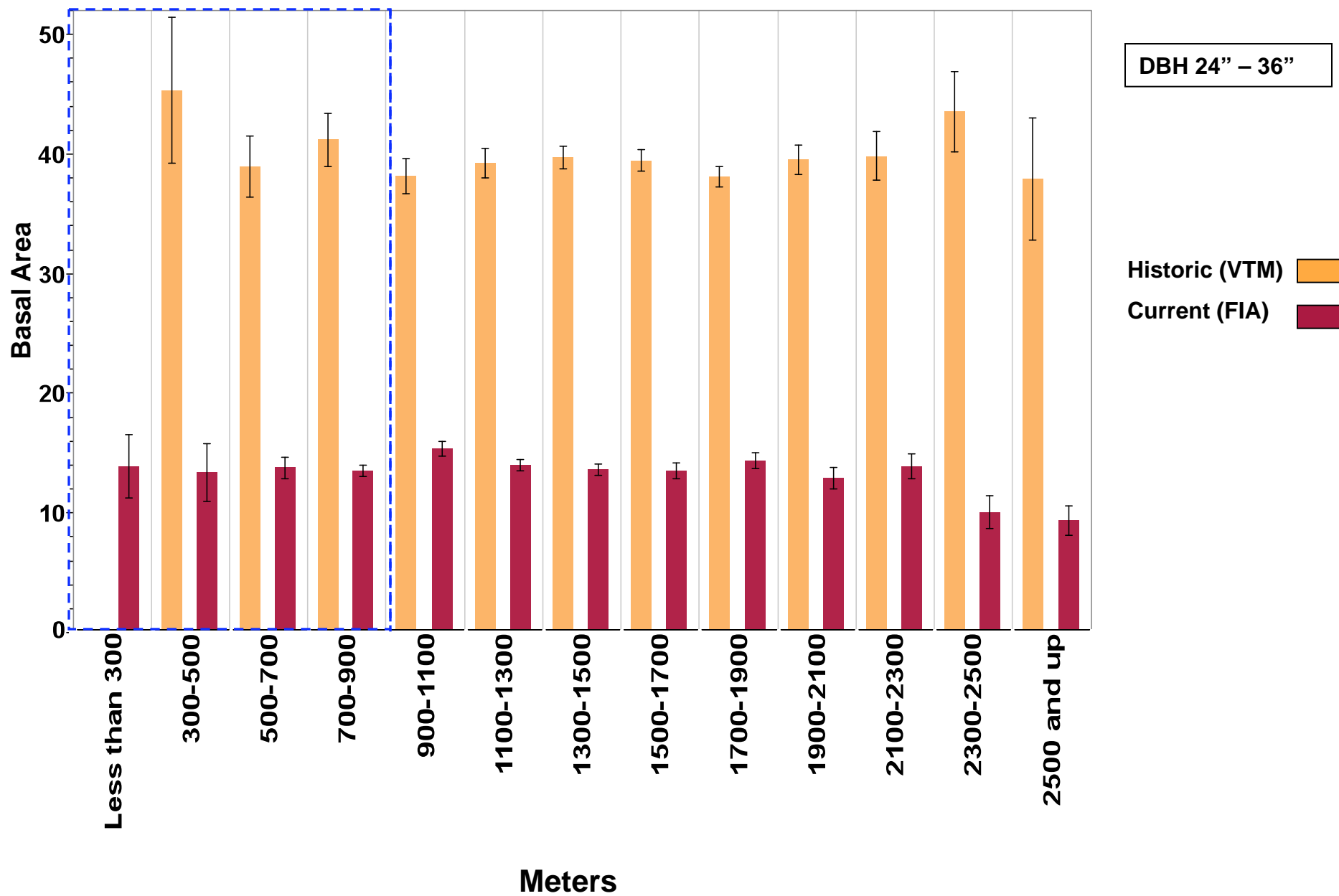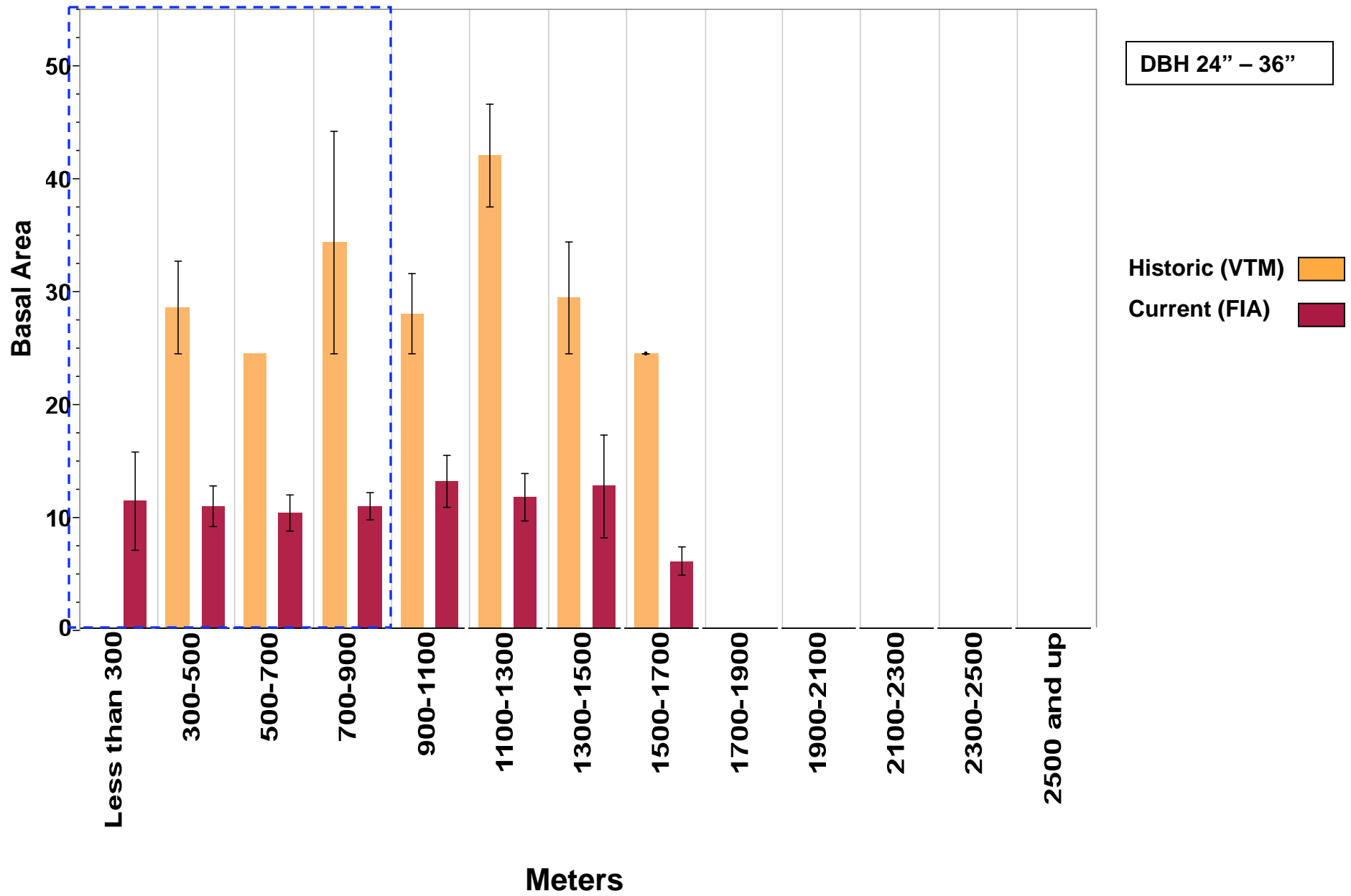| Meters	Historic	Current
Less than 300	253	69
300-500	379	64
500-700	334	108
700-900	297	118
900-1100	278	91
1100-1300	290	98
1300-1500	355	100
1500-1700	393	100
1700-1900	420	129
1900-2100	389	105
2100-2300	298	115
2300-2500	265	78
2500 and up	455	119

Conifers: Pipo, Psme, Pila, Cade, Abco
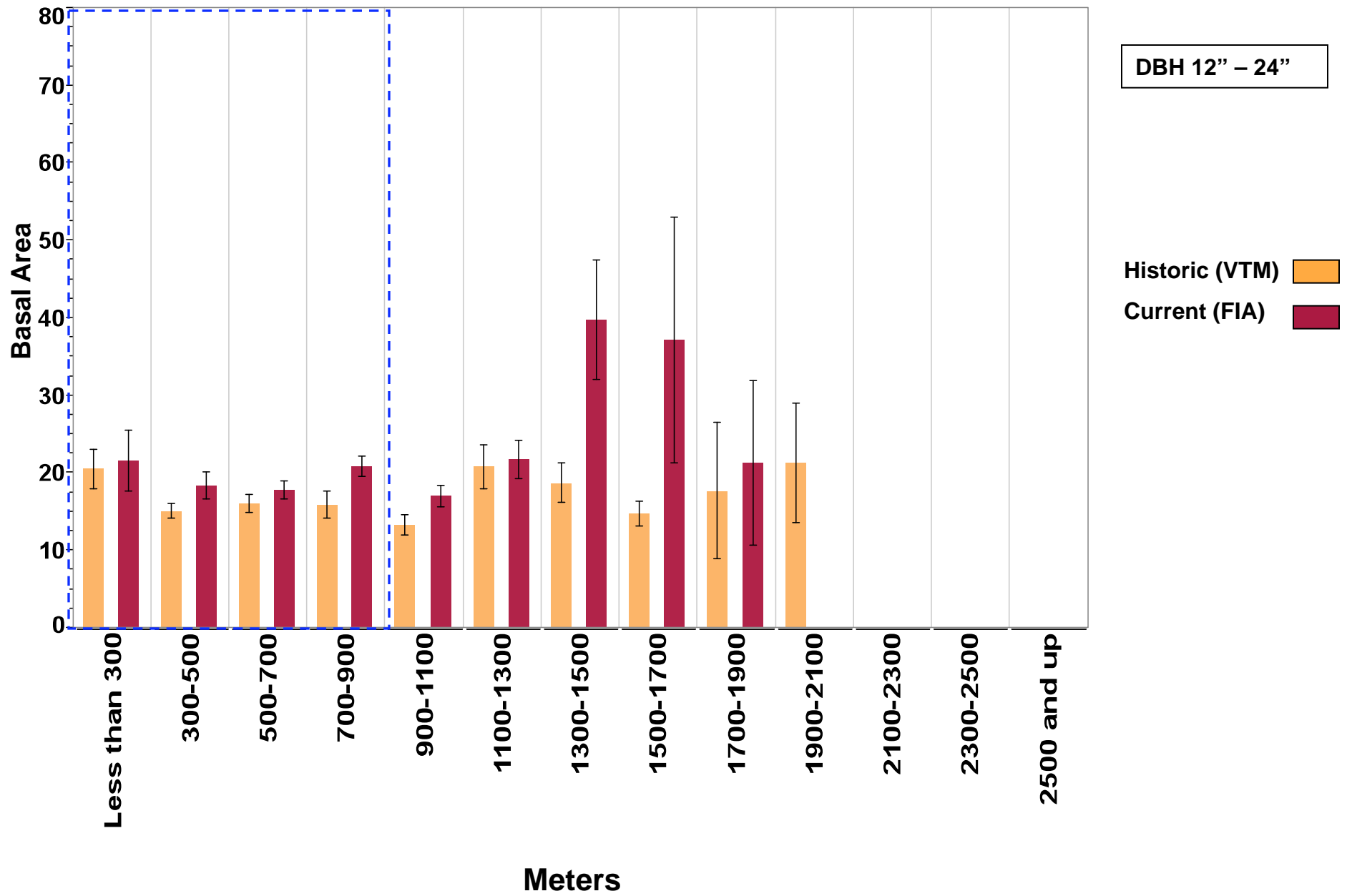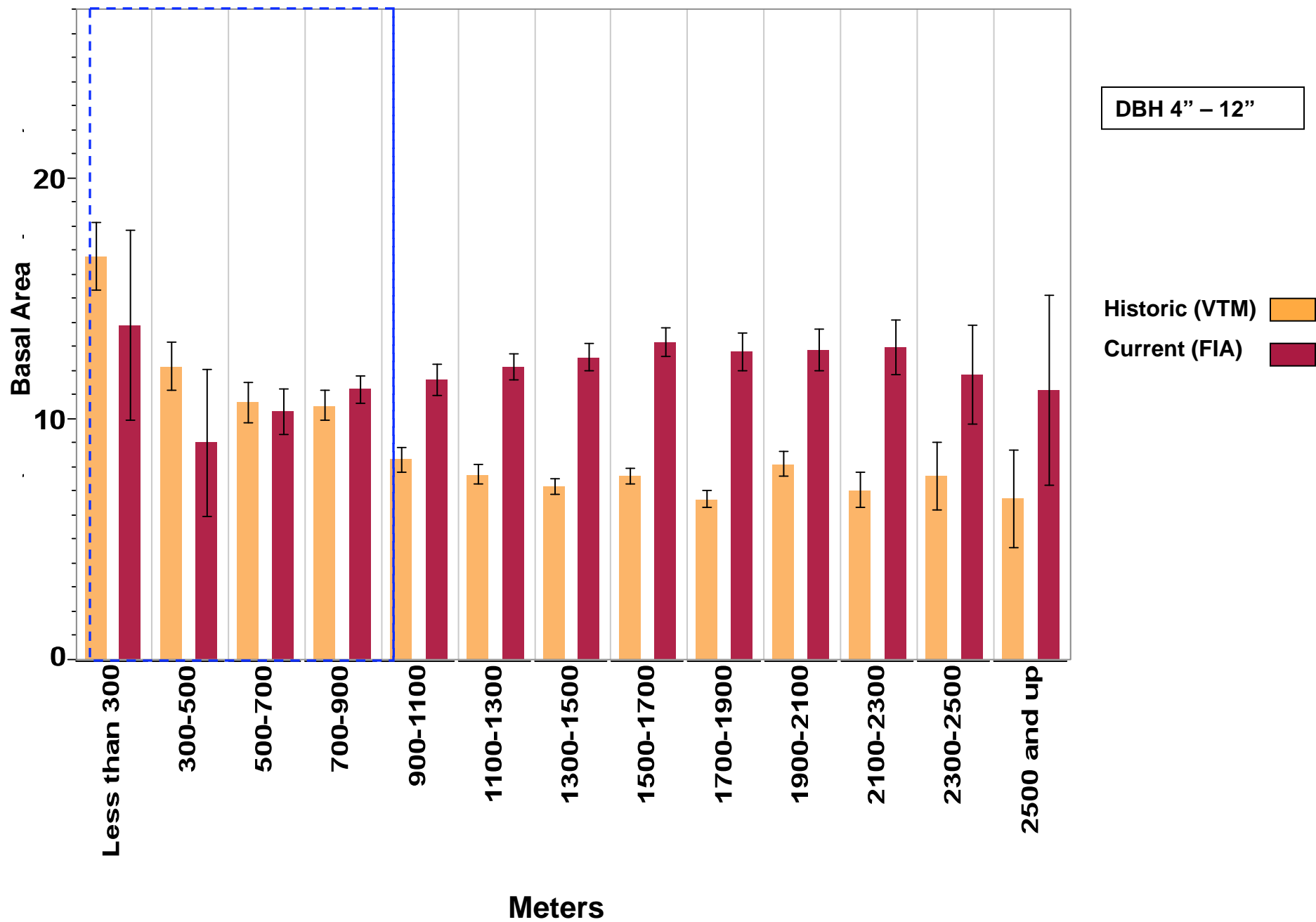
Hardwoods: Quke, Quwi, Quch, Arme, Lide

Conifers

DBH 24" – 36"

Historic (VTM)
Current (FIA)

Basal Area

Meters

Less than 300, 300-500, 500-700, 700-900, 900-1100, 1100-1300, 1300-1500, 1500-1700, 1700-1900, 1900-2100, 2100-2300, 2300-2500, 2500 and up

Hardwoods

DBH 24" – 36"

Historic (VTM)
Current (FIA)

Basal Area

Meters

Less than 300 | 300-500 | 500-700 | 700-900 | 900-1100 | 1100-1300 | 1300-1500 | 1500-1700 | 1700-1900 | 1900-2100 | 2100-2300 | 2300-2500 | 2500 and up

Conifers

DBH 12" – 24"

Historic (VTM)
Current (FIA)

Basal Area

Meters

Less than 300, 300-500, 500-700, 700-900, 900-1100, 1100-1300, 1300-1500, 1500-1700, 1700-1900, 1900-2100, 2100-2300, 2300-2500, 2500 and up

Hardwoods

DBH 12" – 24"

Historic (VTM)
Current (FIA)

Basal Area

Meters

Less than 300
300-500
500-700
700-900
900-1100
1100-1300
1300-1500
1500-1700
1700-1900
1900-2100
2100-2300
2300-2500
2500 and up

Hardwoods

Basal Area vs Meters

DBH 4" – 12"

Historic (VTM)
Current (FIA)

X-axis categories: Less than 300, 300-500, 500-700, 700-900, 900-1100, 1100-1300, 1300-1500, 1500-1700, 1700-1900, 1900-2100, 2100-2300, 2300-2500, 2500 and up

Minimum Temp – Quarter 1

Degrees C

Meters

Historic
Current

Less than 300
300-500
500-700
700-900
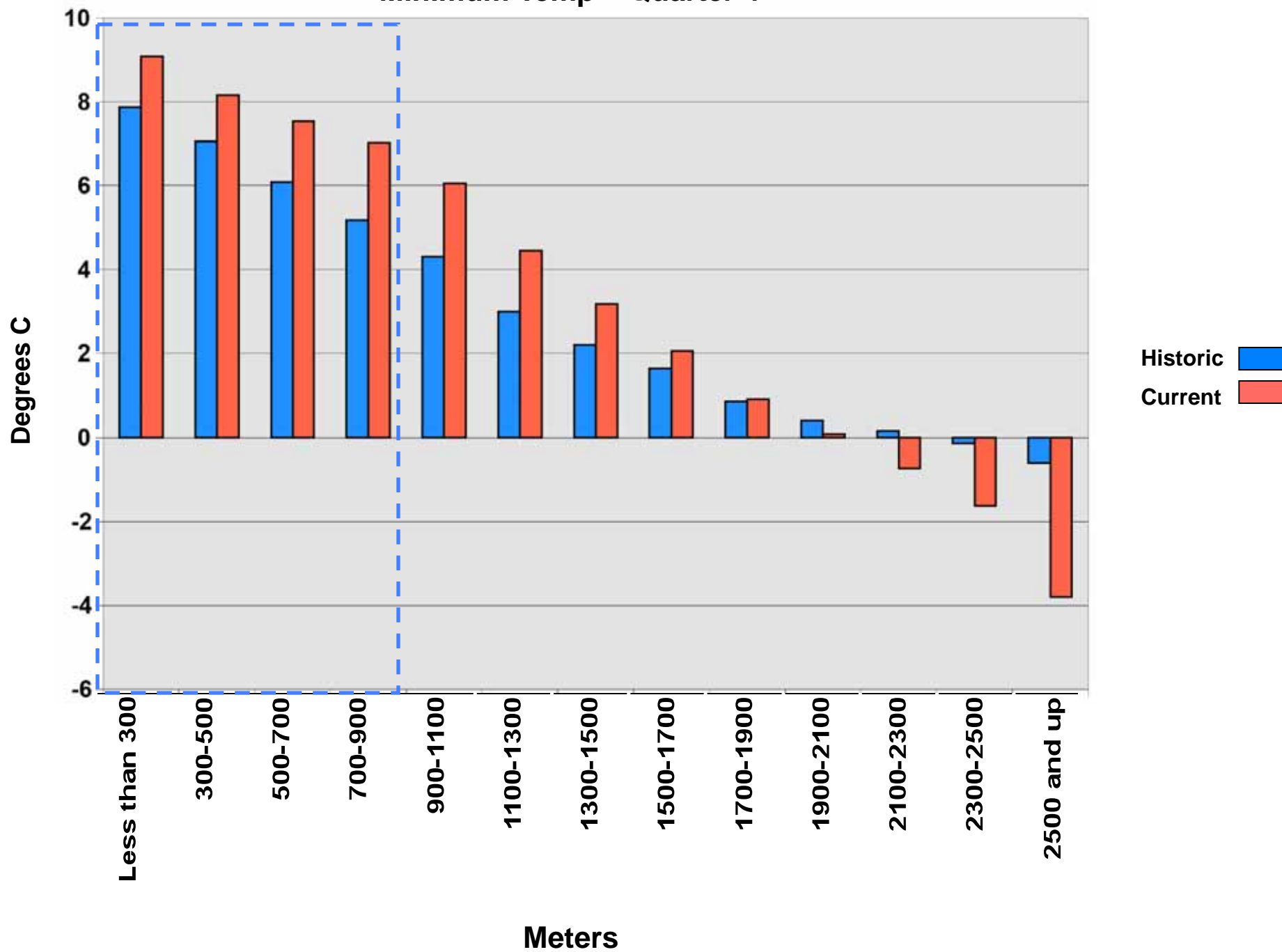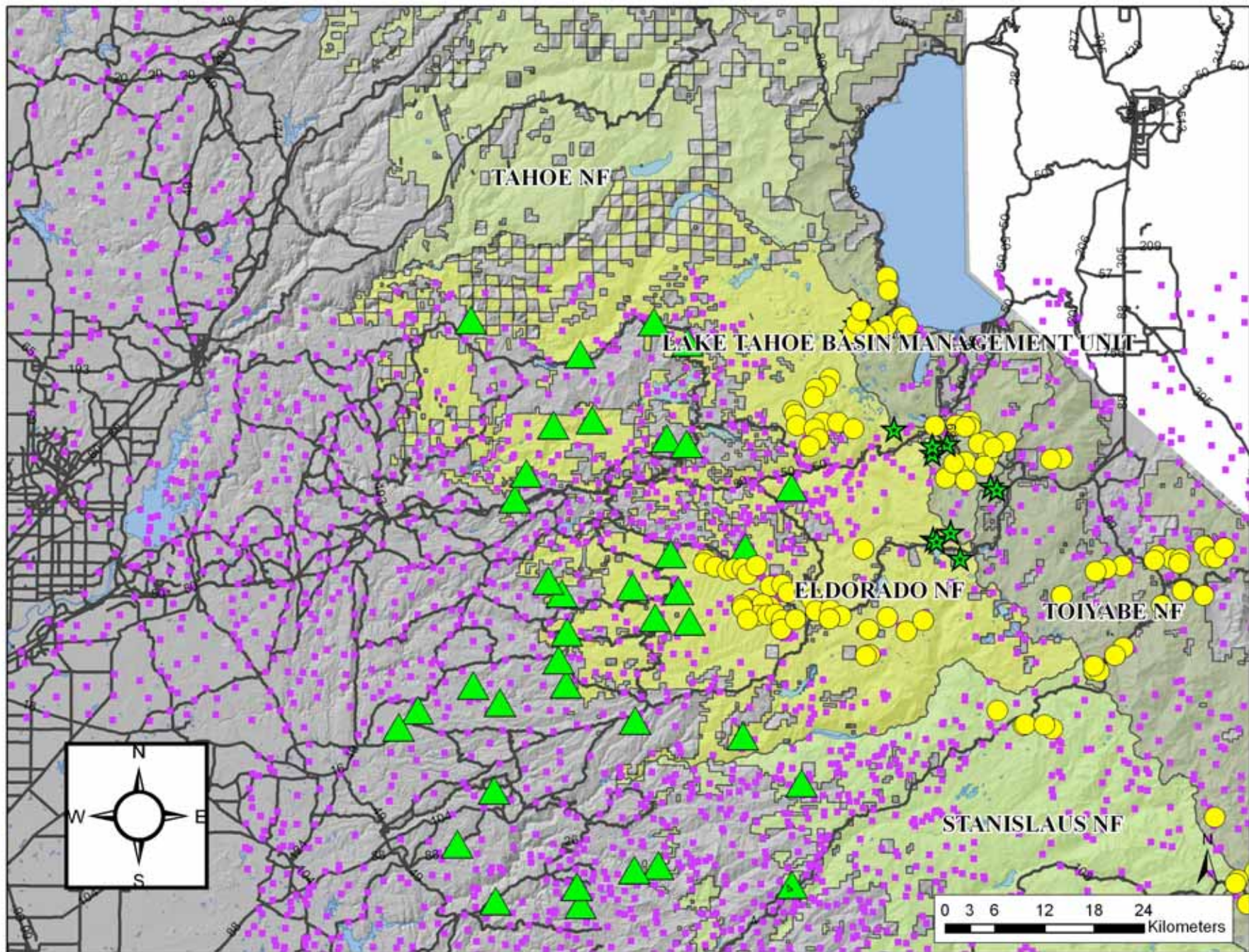900-1100
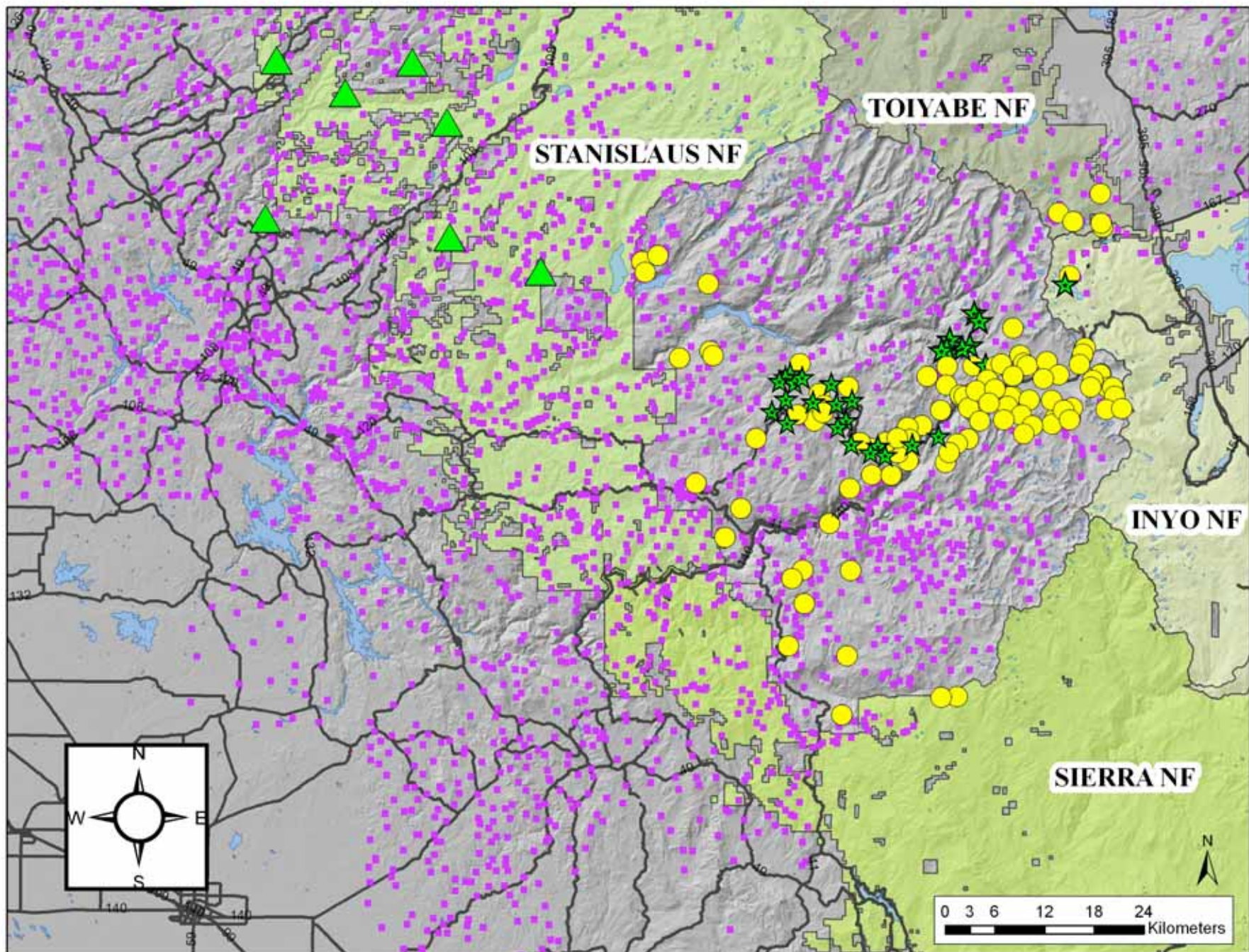1100-1300
1300-1500
1500-1700
1700-1900
1900-2100
2100-2300
2300-2500
2500 and up

Minimum Temp – Quarter 2

Minimum Temp – Quarter 3

Degrees C

Meters

Historic
Current

Less than 300 | 300–500 | 500–700 | 700–900 | 900–1100 | 1100–1300 | 1300–1500 | 1500–1700 | 1700–1900 | 1900–2100 | 2100–2300 | 2300–2500 | 2500 and up

Minimum Temp – Quarter 4

TAHOE NF

LAKE TAHOE BASIN MANAGEMENT UNIT

ELDORADO NF

TOIYABE NF

STANISLAUS NF

N
W E
S

0 3 6 12 18 24
Kilometers

STANISLAUS NF

TOIYABE NF

INYO NF

SIERRA NF

N
W   E
S

0 3 6   12   18   24
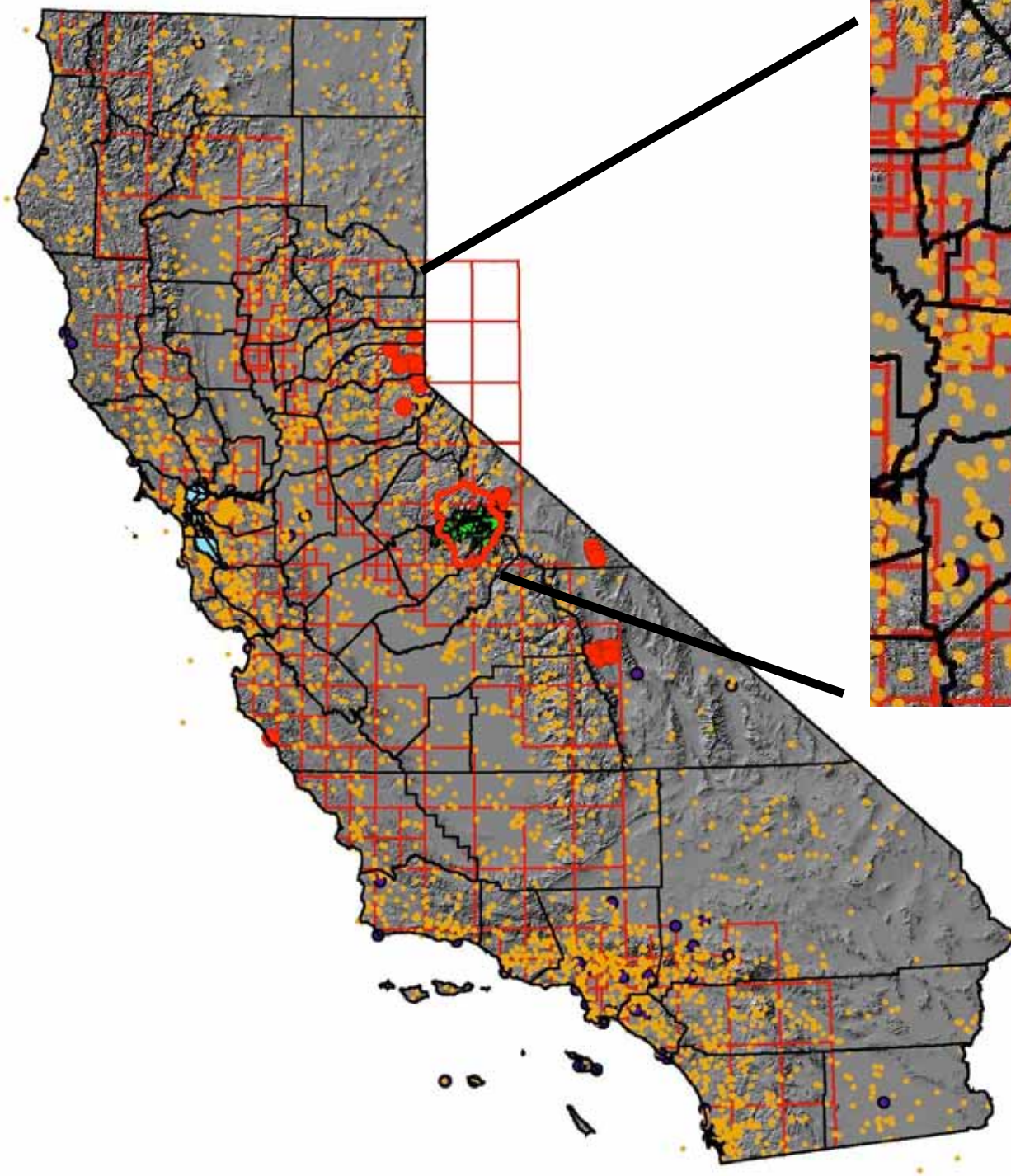Kilometers

N
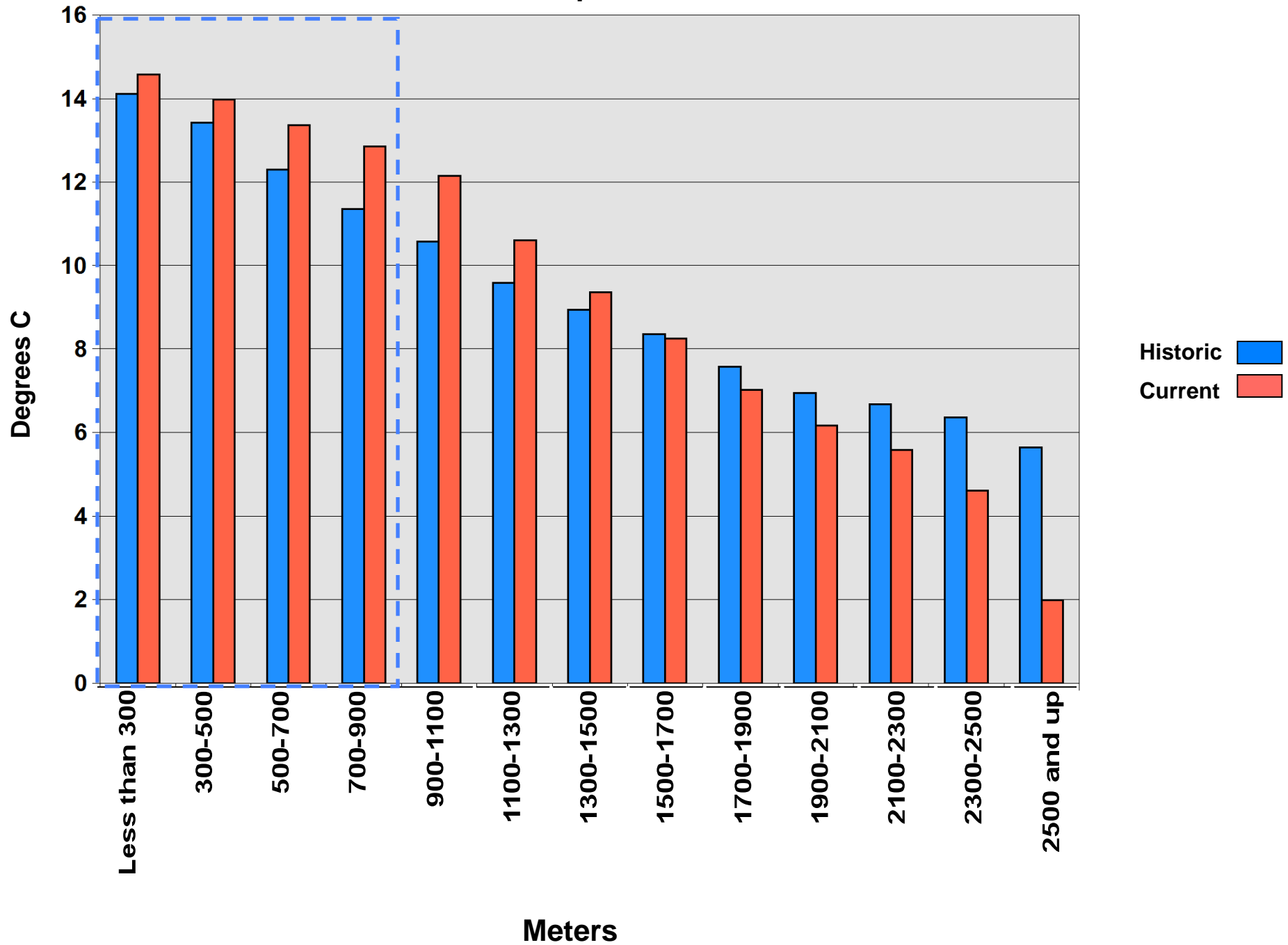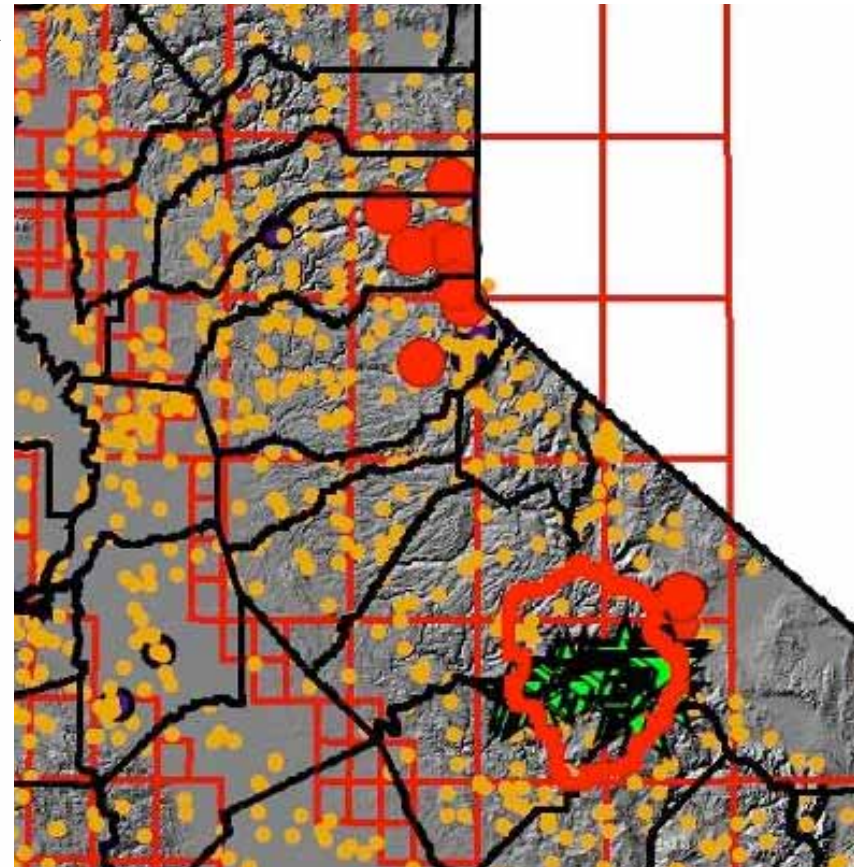
The 3 Locations Identified as Possible Sites for New Weather Stations*
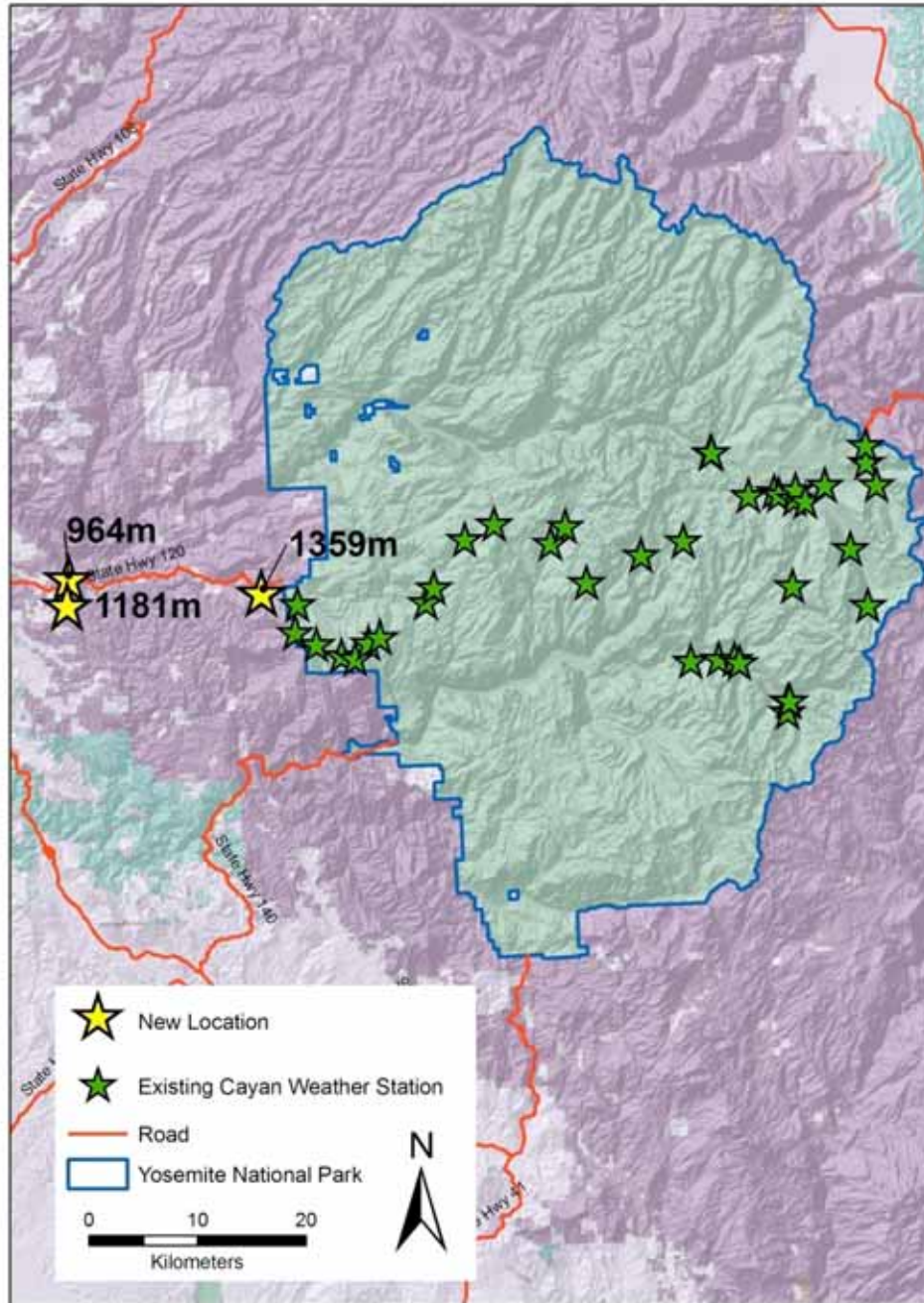
Extension of monitoring transects

964m
1359m
1181m

New Location
Existing Cayan Weather Station
Road
Yosemite National Park

0   10   20
Kilometers

N
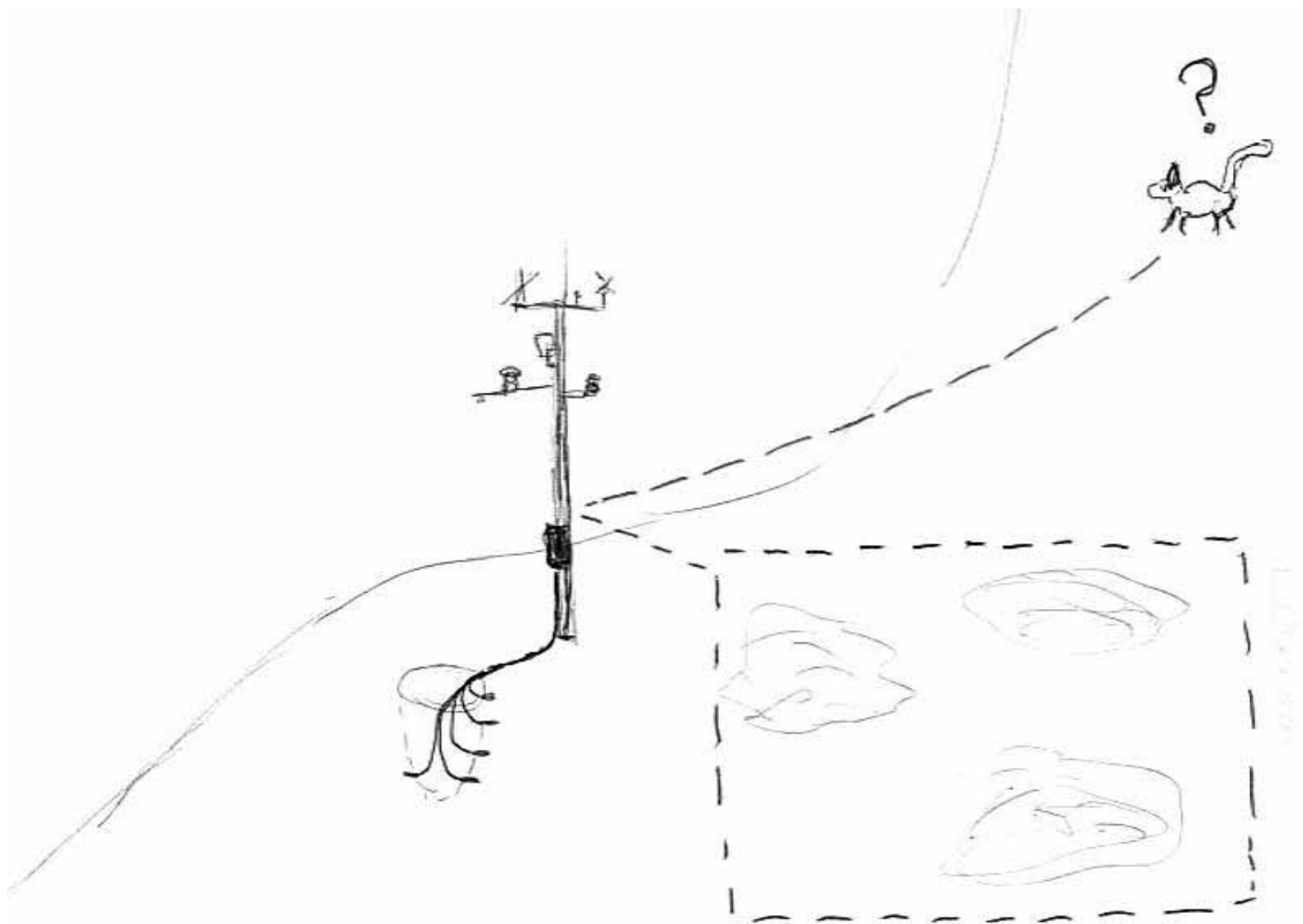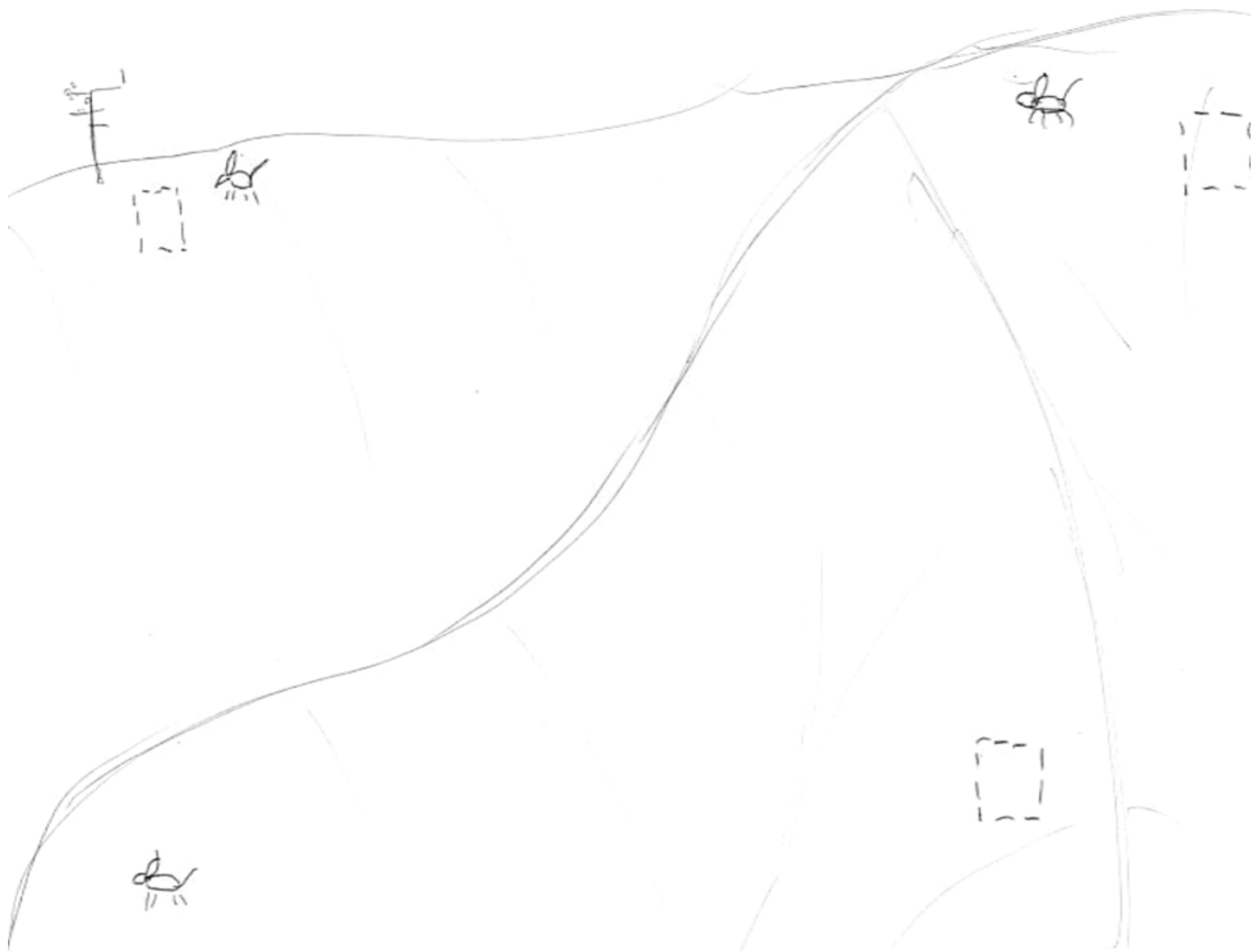
Thank you for your attention
jhthorne@ucdavis.edu